Participation Effects in Household Financial Decisions

by

Stuart Webb

Department of Business Administration
Duke University

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Approved:

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David T. Robinson, Supervisor

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Lukas Schmid

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Manuel Adelino

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Gavan Fitzsimons

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Qi Chen

Dissertation submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy in the Department of Business Administration
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Abstract

This dissertation consists of two essays investigating participation effects in household financial decisions. In the first essay, entitled "Household Mortgage Choice and Mortgage Market Participation," I empirically study a household's choice of an adjustable rate mortgage (ARM) over a fixed rate mortgage (FRM) across time. This decision has been investigated in the cross-section previously, but to date, no one has studied how a household's choice of mortgage contract type changes as they gain experience in the mortgage market. This study investigates whether mortgage market participation has a systematic effect on the choice of an ARM vs. an FRM within a household. Using the Panel Study of Income Dynamics (PSID) and the Survey of Consumer Finances (SCF), I document a novel stylized fact: a household's propensity to choose an adjustable rate ARM over an FRM increases with the number of previous mortgages the household has used. Households do not choose an ARM due to budget or liquidity constraints when increasing housing consumption; nor is the observed pattern of increased propensity to choose an ARM with mortgage market participation explained by the simultaneous relaxation of budget constraints as homeowners participate in the mortgage market. Stabilization of a household's income stream and rising home prices are also ruled out as the source of increasing ARM choice propensity with greater utilization of mortgages, as is expected length of tenure. Evidence is presented supporting the hypothesis that households learn about mortgage products by participating in the market.

In the second essay, entitled "Participation Effects in Refinancing Decisions", I investigate household refinancing decisions in the context of market participation. Using optimal refinance interest rate differentials as derived in Agarwal, Driscoll, and Laibson (2012), I document an important participation effect in the Panel Study of Income Dynamics, whereby households with greater mortgage market participation, as measured by previous mortgages used, are more likely to refinance optimally. This result is robust to potential liquidity constraints, where the household fails to refinance due to an inability to pay any fixed costs associated with the transaction. Participation effects persist even when controlling for the potential of equity extraction as the primary motivation for refinancing. These results are consistent with an information acquisition model, whereby households gain knowledge and understanding of financial transactions by participating in financial markets.

I would like to dedicate my dissertation thesis to my father, James R. Webb. Though I did not set out in my graduate studies with an intention of studying real estate, my research has a real estate focus, a topic to which my father dedicated his life as a researcher and finance professor. I can think of nothing that would have made him more proud, and without him, this thesis would not exist.

Contents

List of Tables

List of Figures

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The help and support of my family and friends were also critical; specifically, my mother Anaïs, brother Clinton, sister Carissa, and my girlfriend Stephanie Eyerly. All meaningfully contributed to the successful completion of my graduate studies. I cannot thank them enough.

1

Mortgage Choice and Mortgage Market Participation

1.1 Introduction

It is important to understand how and why households make decisions in the context of financial markets. The relationship between directly held household financial assets and total financial assets since 2000 can be seen in Figure 1.1. According to the Federal Reserve Board's Flow of Funds Account, households financial assets, in the form of equities, bonds, money market accounts, mutual funds and other assets, amounted to over $41 trillion, or 30% of the US total, in 2009. This is not a trivial amount. As we might expect from looking at Figure 1.1, the aggregate decisions of households clearly have important economy-wide impacts, as demonstrated in the recent financial crisis, where the mortgage market collapsed and it's effects rippled through the rest of the economy.

One potential factor in a household's financial decision making is participation in financial markets. van Rooij, Lusardi, and Alessie (2011) show that financial literacy is correlated with participation in equity markets, so we might expect a household

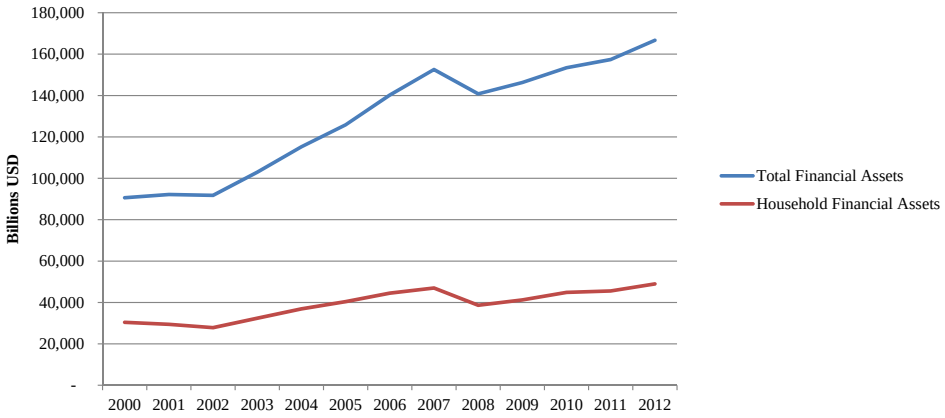

FIGURE 1.1: This graph displays the evolution of directly held aggregate household financial assets along with total financial assets in the U.S. economy. Aggregate household financial assets account for a substantial portion of total financial assets in the economy, varying between 28 and 35% of the total over the last 12 years.

to systematically change its financial decision making process with participation in financial markets. To study this effect, we will turn to the mortgage market, which has some very important advantages in investigating market participation's effects on household decision making. First, purchasing a home is something most households will undertake in their lifetime, with sixty-five percent of all households owning their home, and for households with a head over sixty-five, that number increases to over eighty percent nationally. Second, most households have a substantial portion of their wealth tied up in housing. Because homes usually account for such a large proportion of household wealth, most home purchases are financed with a mortgage, creating a highly levered position in the household's portfolio, making it potentially the most important financial decision a household will ever make. Third, it is a transaction likely to be repeated multiple times by the same household, and finally, data are readily available.

To briefly introduce mortgage contracts, they are complicated financial instruments that come in two broad classes: fixed rate mortgages (FRMs) and adjustable or variable rate mortgages (ARMs). Fixed rate mortgages have a fixed nominal in-

terest rate and constant nominal payment over the life of the loan, which is usually fifteen or thirty years in the United States. There is usually no penalty for prepayment of the loan. While FRMs have a fixed nominal capital value, their real value varies with real interest rates. If rates are low relative to when the loan was taken out, FRMs are expensive and the real wealth of the household falls, while if rates are high, FRMs are cheap and real wealth of the household is relatively large, so there is substantial wealth risk associated with fixed rate mortgages. It should also be noted that FRMs are expensive when interest rates are stable. Households must pay for the prepayment option usually found in fixed rate contracts by paying a higher interest rate than they otherwise would have, if the mortgage did not include a prepayment option.

Adjustable rate mortgages trade off the wealth risk of an FRM for income risk. The interest rate on an ARM adjusts to prevailing nominal rates, usually at a 1 year frequency. Because of these adjustments, ARMs have relatively stable real capital values, but have risky nominal payments, so ARMs are expensive if rates rise. In most cases, initial rates for ARMs are lower than FRMs to compensate borrowers for taking on this interest rate risk. In recent years the one year ARM, where the interest rate adjusts annually starting with the first year and which has been the standard variable rate contract, has all but disappeared from the market. A hybrid contract with an initial fixed rate period, usually 3, 5, or 7 years, followed by a period where rates are adjusted annually, has become the dominant form of adjustable rate mortgages. These contracts are treated as forms of adjustable rate mortgages.

The choice of an ARM vs. an FRM in the cross-section has been extensively studied in the literature. However, no one has investigated how this decision changes within a given household over time. This study will demonstrate that the propensity to choose an ARM increases with mortgage market participation. While controlling for factors found to be important to the choice of mortgage contract type, households

obtaining their second mortgage are about 8 percentage points more likely to acquire some form of adjustable rate loan than they were for their first mortgage. Households who have extensive experience in the mortgage market are even more likely to use an adjustable rate contract. Having 4 or more previous mortgages translates to a 20 percentage point increase in the probability of choosing an ARM as compared to the household's first mortgage. The effects of factors previously shown to influence the choice of an ARM over a fixed rate mortgage, such as likelihood of moving, income volatility and pricing variables are consistent with previous literature, but do not explain the observed pattern.

We can see the significance of housing in household assets in Figure 1.2, which shows house value as a percentage of total assets plotted against the wealth distribution. The data come from the 2009 panel of the Survey of Consumer Finances. For the middle half of the distribution, house value accounts for well over fifty percent of total wealth. For comparison, the percentage of wealth held in corporate equities is also plotted. For all but the richest households, public equities are a negligible component of a wealth when compared to a home. Figure 1.2 also plots the proportion of households who have mortgage debt against the distribution of wealth. We see this closely matches the distribution of house value as a percentage of wealth showing that most households carry mortgage debt

In the United States, fixed rate mortgages are by far the dominant mortgage type. Figure 1.3 shows the fixed rate mortgage market share over the last 22 years. FRMs have been the prevailing contract in the market, ranging between sixty-five percent in the early 2000s and ninety percent of the mortgage market today. There are a number of potential reasons for this fact, including risk aversion, relative complexity of adjustable rate mortgage terms, government supported liquidity and cultural traditions. An FRM has a fixed payment for the entire life of the loan, so the borrower knows exactly how much he will have to pay every month. As well, fixed

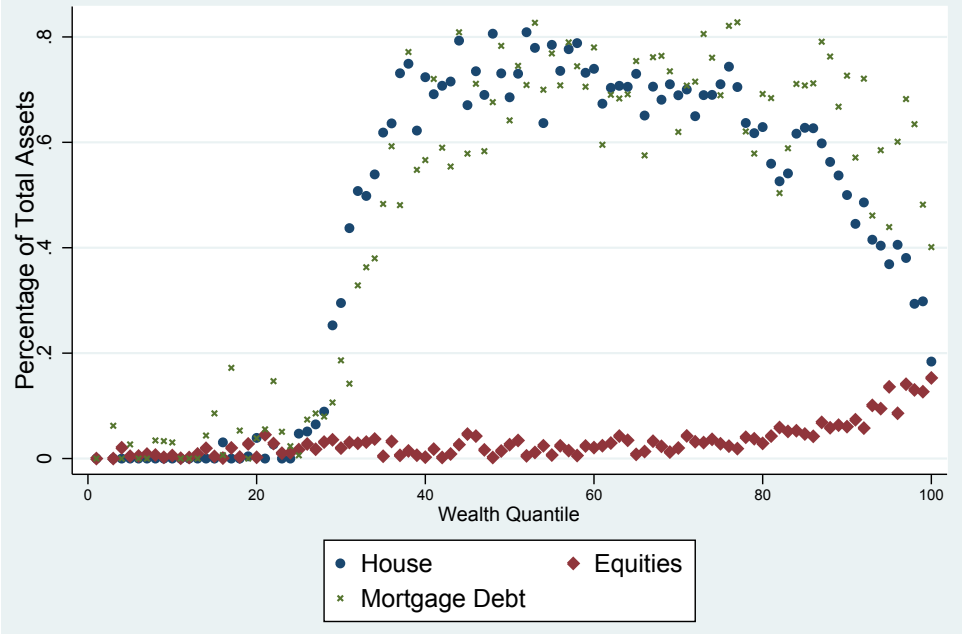

FIGURE 1.2: This graph plots household home prices ("house") and public equity value as a percentage of household assets against the distribution of wealth. "Mortgage Debt" gives the percentage of each wealth quantile that carries mortgage debt. Data come from the 2009 Survey of Consumer Finances (SCF) panel study.

rate contracts are very simple compared to adjustable rate mortgages, consisting of an interest rate, principle and loan term. These two characteristics can be very appealing to households. While an FRM has a fixed nominal payment for a fixed term, adjustable rate contracts often have variable payments. ARMs have additional contractual terms as well, including but not limited to different rate adjustment periods, an interest rate index which determines changes in payments, and annual and life-of-loan rate caps.

State support for fixed rate mortgages is executed by government sponsored entities such as Fannie Mae, Ginnie Mae and Freddie Mac. Fannie Mae's stated purpose is "to keep money flowing to mortgage lenders, to help strengthen the U.S. housing and mortgage markets, and to support affordable homeownership." By buying loans from mortgage lenders, Fannie Mae has helped maintain high liquidity in mortgage lending markets, keeping rates low. Ginnie Mae acts as a guarantor for the timely

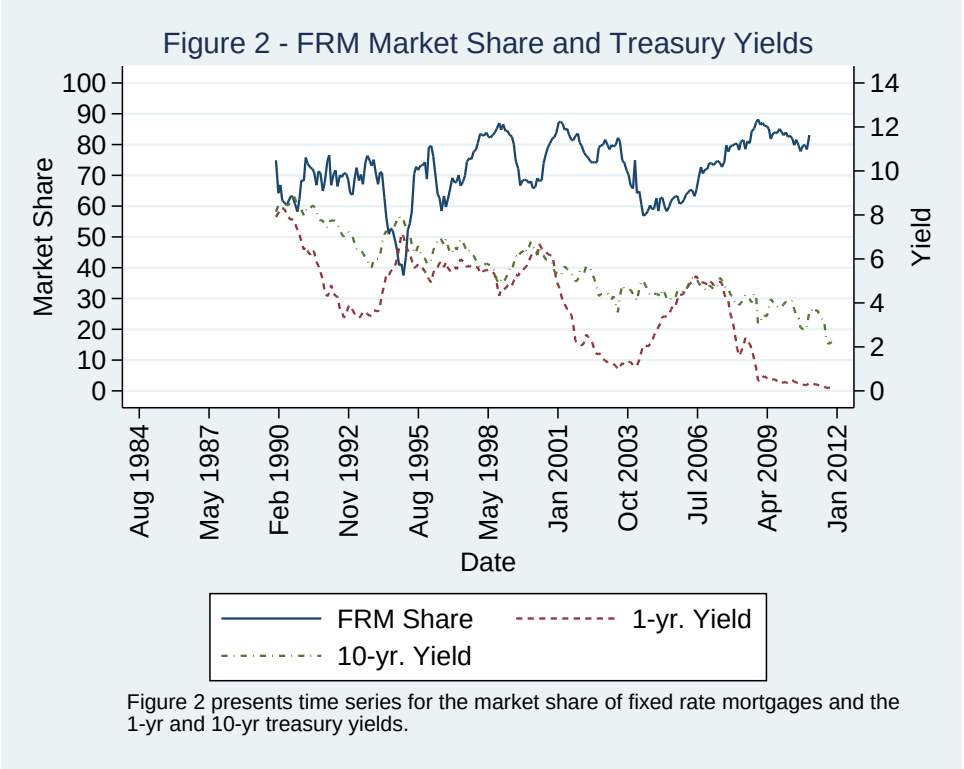

FIGURE 1.3: Figure 2 presents time series for the market share of fixed rate mortgages and the 1-yr and 10-yr treasury yields. Data come from Freddie Mac's Primary Mortgage Market Survey and United States Department of the Treasury

payment of mortgage interest and principle, allowing mortgage lenders to get better prices in the secondary market and keep rates low. Freddie Mac is an intermediary, buying consumer loans on the secondary market and issuing guaranteed mortgage backed securities with these loans as the underlying asset. Government support for consumer mortgage markets in the form of these three entities has maintained a highly liquid secondary market for mortgages. High liquidity reduces the costs of lending and maintains mortgage rates at relatively low levels. Finally, adjustable rate contracts were not available until the 1980s, when they enjoyed some popularity due to high interest rates. However, by this time government supported fixed rate contracts were what most people thought about when discussing mortgages, and little has changed today.

Though fixed rate contracts have the lion's share of the market, little work has been done investigating which type of mortgage is best for households. Campbell and Cocco (2003) is one exception. The authors build a life-cycle model of mortgage choice and examine the welfare implications of nominal FRMs and ARMs. Results show that FRMs should be relatively more desirable for households with large homes relative to income, high income volatility, low probability of moving and high default costs. However, when the model is calibrated to data from 1986 to 1999, an FRM is never better in a welfare sense than an ARM.

Empirically, Dhillon, Shilling, and Sirmans (1987) argue that mortgage pricing variables are the main determinant of mortgage choice and that borrower characteristics play little to no role in this decision. One possible caveat to this which the authors discuss is borrower mobility. Because of the lower initial rates of ARMs and relative stability of interest rates over short horizons, if a borrower expects to move in the near future they should be more likely to choose an adjustable rate mortgage. Brueckner and Follain (1988) add support for this argument.

Borrower characteristics have been shown to play a role, however, when differentiated ARM contracts are considered. Sa-Aadu and Sirmans (1995) show that when different types of variable rate mortgages are available, such as 5/1 or 7/1 ARMs, more mobile and younger borrowers choose shorter initial fixed rate terms. Additionally, Stanton and Wallace (1998) show that the menu of points and rates given for FRM contracts serves as a method of separating higher mobility borrowers from lower mobility borrowers, with higher mobility borrowers paying less in points and taking a higher interest rate. Brueckner (1994) shows that the most mobile borrowers will self-select into ARM contracts, and as discussed earlier, Campbell and Cocco (2003) add to the theoretical support for the argument that highly mobile borrowers benefit from the lower rates on ARMs.

Phillips and Vander Hoff (1991) show that mortgage choice is sensitive to initial

"teaser" rates on ARMs and the ratio of points on FRMs to points on ARMs. They also find that the level of housing prices is positively related to the choice of an ARM. Using the Survey of Consumer Finances (SCF) Coulibaly and Li (2009) give evidence further supporting the role of pricing in mortgage choice. Additionally, they give empirical support to the argument of Campbell and Cocco (2003) that more risk averse home buyers will have a lower propensity to choose an adjustable rate mortgage. Koijen, Hemert, and Nieuwerburgh (2009) show that the bond risk premium, defined as the difference between long term interest rates and expected average short rates for the same horizon, explains a large portion of ARM share in the aggregate and ARM choice at the micro level. They find that a household decision rule using the average of recent short rates and long term treasury yields is the best predictor of ARM share.

This study will break from this literature by studying the mortgage choice decision repeatedly across time within a household. To date, the impact of mortgage market participation and its interaction with factors shown to be important in the cross-section has not been studied. It will show that participation in the mortgage market has an important impact in the choice of an ARM vs. an FRM, in addition to previously identified variables.

Classic finance theory shows that in a frictionless world, households make mean variance efficient choices. However, in practice there are many frictions. Addoum (2012) shows that when a households consists of more than a single individual, bargaining considerations become important. If risk aversion of household members is different, portfolio allocations can be different than if either individual were making the decision independently. van Rooij, Lusardi, and Alessie (2011) show that financial literacy is an important determinant of a household's financial decisions. They devise an index of financial literacy and show that stock market participation is positively related to financial literacy. Additionally, they show that literacy increases

with age, and comment that people may be be gaining financial sophistication as they participate in financial markets. This paper gives support for that argument showing experience in financial markets is a key component of household financial decisions.

The rest of the paper will have the following structure. Section II will present and summarize data used to show that households learn about ARMs and their advantages. Section III will present the main methodology and results. Section IV will give robustness checks and finally, Section V will conclude.

1.2 Data

Data from several sources are used to examine household mortgage choice decisions, including the Primary Mortgage Market Survey (PMMS), Survey of Consumer Finances (SCF) and the Panel Study of Income Dynamics (PSID).

1.2.1 Panel Study of Income Dynamics

Data from the Panel Study of Income Dynamics (PSID) is the primary source for the analysis. The PSID is the longest running longitudinal study in the world and was administered annually from 1968 until 1997. Since 1997, data have been collected biennially and the most recent year for which data are available is 2009. Data from the 1978 wave onward are used to impute the number of mortgage contracts a given household has used in its lifetime. Regression analysis uses ten unbalanced panels, the PSID waves from 1996-1997 and the biennial surveys from 1999 to 2009.

The PSID asks "Do you have a mortgage or loan on this property [home]?" in every year of the survey since 1983 and in the 1979-1981 period. The questionnaire goes on to ask "What year did you obtain that loan?" since the 1997 survey. Responses to these two questions are used to impute the number of mortgages the household has had and to create a sample of mortgage choice decisions. Additionally,

the survey asked "What is the current interest rate on that loan?" since 1996, and in the years 1996, 2007 and 2009 "Is the interest rate on that mortgage or loan fixed or variable?" Responses to the second question give a direct answer to the question of the loan being an FRM or ARM, but changes in the reported interest rate can be used to impute the loan type (ARM vs. FRM) by comparing rates across years for loans within a household with the same origination year.

Table 1.1 has summary statistics for the PSID. Panel B gives summary statistics by year for wealth, income, and demographic variables. Panel (A) gives values for the whole sample, (B) for homeowners, (C) for mortgagors, and panel (D) gives summary statistics for households with a new mortgage. Homeowners tend to be wealthier than non-homeowners, consistent with Figure 1.2, however, there is no appreciable difference in total assets between all homeowners and the subset of homeowners with mortgages. Mortgagors have higher income than homeowners in general, likely due to a larger fraction of retirees owning their homes outright. We see the rise in home values associated with the run-up to 2007, followed by the subsequent fall in house prices. There are no appreciable differences in education between new mortgagors and mortgagors in general. If the household enters the sample with a mortgage, that is assumed to be the first mortgage contract the household has ever had. The average age at which households enter the estimation sample is 30 years of age, so it is likely that any mortgage held when entering the sample is close to the first mortgage of the household. Panel (E) gives the distribution of total mortgages a households has held when a new mortgage is taken out. We see there is substantial variation across the number of mortgages previously held. Analysis will account for the systematic differences shown here.

Table 1.1: This table gives median values for dollar denominated variables and age, and mean values for binary variables for the PSID. Values are computed using the weights provided in the PSID. Panels A-D give means by year from 1999 to 2009. Panel (A) gives values for the entire PSID. Panel (B) gives values for homeowners only. Panel (C) gives values for mortgage holders, and Panel (D) gives values for mortgages initiated in the specified year. Panel (E) gives the distribution of previous mortgages for households with a new mortgage. This will be our measure of mortgage market participation.

Panel A - Overall

	Total Assets	Income	Principal	Net Worth	House Value	Age	Education	Homeowner
1999	119	51	0	66	77	46	12	0.64
2001	129	52	0	73	85	47	12	0.65
2003	135	50	0	71	93	48	12	0.66
2005	148	49	0	76	99	48	12	0.65
2007	151	50	0	78	98	49	13	0.64
2009	128	50	0	53	89	50	13	0.62

Panel B - Homeowners

	Total Assets	Income	Principal	Net Worth	House Value	Age	Education	Mortgage
1999	213	64	37	148	130	51	13	0.65
2001	225	66	39	160	151	51	13	0.67
2003	245	65	47	160	163	51	13	0.67
2005	275	65	55	186	187	52	13	0.68
2007	300	68	54	200	207	53	13	0.67
2009	263	69	59	160	180	54	14	0.68

Panel C - All Mortgages

	Total Assets	Income	Principal	Net Worth	House Value	Age	Education	New Mortgage
1999	210	76	77	117	148	45	14	0.44
2001	228	78	84	127	157	46	14	0.32
2003	246	76	93	129	175	46	14	0.54
2005	278	77	100	152	198	47	14	0.52
2007	303	79	106	167	223	48	14	0.36
2009	257	80	110	123	200	49	14	0.29

Panel D - New Mortgages

	Total Assets	Income	Principal	Net Worth	House Value	Age	Education	Refinance
1999	219	78	103	103	161	42	14	0.46
2001	219	77	101	95	164	42	14	0.35
2003	278	84	128	135	209	45	14	0.63
2005	311	82	132	152	220	44	14	0.56
2007	298	76	150	125	233	43	14	0.44
2009	281	81	150	106	205	45	14	0.51

Panel E - Distribution of Number of Mortgages

Mortgages	1	2	3	4	5	6	7	8
	30.67%	35.26%	18.80%	9.54%	4.07%	1.34%	0.29%	0.04%

1.2.2 Survey of Consumer Finances

The Survey of Consumer Finances, normally a cross-sectional survey administered every three years, extended their 2007 study to include a 2009 re-interview, creating a longitudinal data set. This panel includes almost 4,000 (3,857) households and includes an oversample of the wealthy. Weights are included so unbiased estimates for US totals can be calculated. Participants give extensive data about mortgages, financial assets and expectations. Additionally, household characteristics are collected, including employment, education, and demographics. Table 2 gives summary statistics by year and mortgage status for financial and mortgage variables, using the weights provided by the survey.

The first section of Table 1.2 has statistics for the whole sample, and we see that wealth, measured as both total assets and net worth, fell between 2007 and 2009 as did income. The proportion of the sample who owned their home was relatively stable at about 70%. The second section of the table gives summary statistics for these homeowners. Almost 69% of homeowners had a mortgage in 2007, which fell slightly to 65% in 2009. Importantly, house values fell considerably during this time period, dropping nearly 17% from a little over $300,000 to about $250,000. The third section of Table 2, which shows statistics for households with a mortgage, indicates that the number of mortgages initiated in the previous year rose slightly from 29% to about 32%. We also see that about 14% of mortgages outstanding were variable rate in 2007, which fell slightly to about 12% in 2009. More significantly, the proportion of new mortgages that were adjustable rate fell dramatically between 2007 and 2009, which can be seen in the final section of the table. The last section shows statistics for those who took out a mortgage in 2007 or 2009. We see that a little over 18% of newly initiated mortgages were adjustable rate in 2007, but this fell to just over 8% in 2009. Additionally, the proportion of new mortgages that were

Table 1.2: This table gives summary statistics for the Survey of Consumer Finance 2007-2009 Panel, by year and mortgage status. Wealth falls for all categories, while income remains the same for all but new mortgages, where income rises. This shows that new mortgagors generally have higher incomes in 2009 than in 2007. Otherwise, patterns are largely similar to those for the PSID.

		All		Homeowners		All Mortgages		New Mortgages	
	Variables	Mean	Median	Mean	Median	Mean	Median	Mean	Median
2007	Total Assets	497,946	189,124	685,660	298,884	612,854	310,559	564,217	305,444
	Total Income	85,637	47,596	105,356	61,668	108,250	72,429	99,794	68,083
	Original Principal	184,956	145,577	184,956	145,577	184,956	145,577	210,438	173,838
	Net Worth	509,271	104,238	697,405	201,519	553,900	173,171	435,763	122,124
	House Value	211,524	124,164	302,528	206,940	323,124	228,669	320,806	243,569
	Age	49	48	53	52	48	47	44	42
	Education	13	13	14	14	14	14	14	14
	Homeowner	0.70	1	1	1	1.00	1	1.00	1
	Mortgage	0.48	-	0.68	1	1	1	1	1
	ARM	0.07	-	0.10	-	0.14	-	0.18	-
	New Mortgage	0.13	-	0.19	-	0.27	-	1	1
	Refinance	0.22	-	0.31	-	0.45	-	0.39	-
2009	Total Assets	429,174	170,084	582,510	258,630	519,232	267,380	542,868	281,668
	Total Income	80,662	49,200	96,957	60,200	105,062	75,200	102,989	78,000
	Original Principal	187,451	148,196	187,451	148,196	187,451	148,196	198,057	158,661
	Net Worth	410,821	79,882	554,619	150,734	429,134	119,425	429,553	111,324
	House Value	180,479	115,600	252,552	175,000	270,588	195,000	294,276	211,800
	Homeowner	0.71	1	1.00	-	1.00	1	1.00	1
	Mortgage	0.47	-	0.65	1	1.00	1	1.00	1
	ARM	0.05	-	0.08	-	0.12	-	0.08	-
	New Mortgage	0.15	-	0.21	-	0.32	-	1.00	1
	Refinance	0.08	-	0.11	-	0.17	-	0.50	1

refinances rose significantly between 2007 and 2009, jumping from 39% to over 50%. Overall, households increased their refinancing activity and decreased their usage of adjustable rate mortgage instruments.

1.3 Analysis

1.3.1 PSID

Variables

The long running PSID, with its panel structure and extensive data, is a valuable resource to investigate within-household financial decision making. The empirical model of interest is the household fixed-effect model,

$$ARM_{it} = \Gamma * PREV\ MORTG_{it} + \beta * X_{it} + \Psi * AFE_{it} + \epsilon_{it} \tag{1.1}$$

The dependent variable, ARM_{it}, is an indicator variable taking a value of 1 if the household chooses an ARM. The vector $PREV\ MORTG_{it}$ is defined as $PREV\ MORTG_{it} =$

$[PM_{it}^{2}, PM_{it}^{3,4}, PM_{it}^{5+}]$. The first variable takes a value of 1 if the household has had only one previous mortgage (i.e. the current loan is only the second one in the life of the household). The second component takes a value of 1 if the current loan is the third or fourth in the life of the household, and the final element takes a value of 1 if the current loan is the fifth or greater for the household and zero otherwise. The vector of controls, X_{it}, includes those listed in Table 3, which will be discussed in detail below.

We also have an additional control vector, AFE_{it} which consists of various fixed effects beyond the household fixed effect estimator being used. These include $REGION_{it}, YEAR_t$, and $TIME_t * INDUSTRY_{it}$. Historically, ARMs have been a more popular choice in certain geographic areas of the country. The Western portion of the United States, where real estate prices are relatively high has had a greater proportion of mortgages originated as adjustable rate loans. Regional fixed effects, $REGIONS_{it}$, are included to control for these systematic differences in the propensity to choose an ARM across geographic areas. The price of an adjustable rate mortgage relative to a fixed rate mortgage has varied over time. Additionally, there are other time specific factors that should be controlled for in a regression context, such as regulation (Campbell, Ramadorai, and Ranish (2012)), the overall health and performance of the economy, and the interest rate environment at any given time (Koijen et al., 2009). These factors should influence mortgage choice and time fixed-effects are included to account for them. Additionally, time-industry interaction effects are included to account for income volatility within industry and across time. Income volatility will be discussed in more detail later.

Table 1.3 presents the elements of X_{it}. As discussed earlier, the shorter the expected tenure of a household in a given home, the larger the relative benefits of an adjustable rate mortgage. If the household is moving soon, interest rates should be relatively stable over the household's expected life of the loan and the house-

Table 1.3: This table lists and explains the main covariates used in the regression analysis for the Panel Study of Income Dynamics

Variable	Description
DEFINITELY MOVE	Indicator for self reported probability of moving in the next 2 years of
LIKELY MOVE	Indicator for self reported probability of moving in the next 2 years being "probably move"
MAYBE MOVE	Indicator for self reported probability of moving in the next 2 years being "maybe move"
MOVED	Indicator if the household moved
NET WORTH	Assets less liabilities of the household
NW/HOUSE VALUE	Net worth normalized by original principal on the mortgage
HVAL/INCOME	Value of the home normalized by total income
TOTAL INCOME	Total household income from all sources for the year in which the mortgage was originated
INCOME/MPMT	Total annual mortgage payments normalized by total income
LOAN-TO-VALUE	Original principal as a percentage of the purchase price of the home
LOAN-TO-VALUE^2	Loan-to-value squared
REFINANCE	Indicator equal to 1 if the loan was to refinance an existing mortgage
EMPLOYED	Indicator equal to 1 if the head of the household is employed
RETIRED	Indicator equal to 1 if the head is retired.
AGE	Age of the head of the household
AGE^2/100	Age of the head squared
CHILDREN	Indicator equal to 1 if children are part of the household
NUM CHILDREN	The number of dependent children in the household
MALE	Indicator equal to 1 if the head of the household is male
WIFE POWER	A measure of the realative bargaining power of the wife in the household
MARRIED	Indicator equal to 1 if the head of the household is divorced
DIVORCED	Indicator equal to 1 if the head of the household is married
WIDOWED	Indicator equal to 1 if the head of the household is widowed
SEPARATED	Indicator equal to 1 if the head of the household is separated

hold can take advantage of the lower initial interest rate. The PSID includes the question, "Would you say you definitely will move [in the next couple of years], probably will move, or are you more uncertain?" Indicator variables for the households expected probability of moving are included to account for this effect in a non-parametric way. Household mobility is encoded as four variables (see Table 1.3). The variable $DEFINITELY\ MOVE_{it}$, which takes a value of one if the household reports it will move with certainty. If the household reported it would "probably" move, $LIKLEY\ MOVE_{it}$ is set to one. Finally, $MAYBE\ MOVE_{it}$ is one when the household reports its likelihood of moving as "more uncertain". The baseline case is if the household reports it will not be moving. Following the literature, an additional control for mobility is included in the form of an indicator variable if the

new mortgage is the result of a move, $MOVED_{it}$, the idea being that households which have recently moved will likely move sooner than those who have had a long tenure in their current home.

Previous research has shown (Campbell and Cocco, 2003) that the risks associated with variable rate loans are less important to high net worth households. If interest rates adjust unfavorably, higher wealth households will be able to pay their mortgage out of wealth stock if necessary, mitigating the potential for costly downward adjustments in consumption. The variable $NET\ WORTH$ is included to account for this level effect. Additionally, the house size relative to net worth can be important. Even if a household has a large stock of wealth, if the mortgaged house is expensive relative to wealth, potential payments in an unfavorable interest rate environment could be large. The ratio of net worth to principal, $NW/HOUSE\ VALUE_{it}$ is included as a measure of the possible impact of the mortgage on the wealth of the household.

The burden of the mortgage on household income is also important. The inherent variability of ARM payments will be less of a consideration for high income households because, in a high interest rate, and consequently mortgage payment environment, high income households will be less likely to require adjustments to consumption to meet their mortgage obligations. $TOTAL\ INCOME_{it}$ is included because of this potential influence on mortgage choice. Obviously, a household's mortgage obligation relative to its income is also an important consideration. Families with large mortgage payments relative to income will be more likely to require costly adjustments to consumption in unfavorable interest rate conditions if using an ARM. To measure and control for this effect, the ratio of annual income to annual mortgage payments, $INCOME/MPMT_{it}$ is included in the analysis.

If interest rates rise when house prices fall, $LOAN-TO-VALUE_{it}$, the ratio of originating principal to the purchase price of the house, may be an important factor

when deciding on a type of mortgage. When interest rates are high, a household with an adjustable rate mortgage may no longer be able to afford mortgage payments. Selling the home and reducing housing consumption is a potential option for dealing with this situation. However, if house prices are simultaneously low, the home may be underwater, and selling the home would not provide enough proceeds to pay off the remainder of the loan. Mortgages originated with a high loan-to-value ratio are at higher risk for this situation (Deng, Quigley, and Order, 2000), and ARMs may be less attractive to homebuyers with a high loan-to-value ratio. To account for any non-linearities in this relationship, $LOAN-TO-VALUE_{it}^2$ is also included.

One of the primary motivations for refinancing is to lock in low fixed rates. One recently published popular press personal finance book says, "For those of you eager to reduce your mortgage costs, today's record low mortgage rates offer an incredible deal. As of early 2011, the 30-year fixed-rate mortgage has an average interest rate below 5%" (Orman, 2011). The author mentions only fixed-rate mortgages, and it is implicit in the statement that, in the author's opinion, an FRM is the only type of mortgage one should consider when refinancing. In addition, according to the Refinance Product Transition Report from Fannie Mae, 86% of refinances since 1990 have been to some type of fixed-rate mortgage product. An indicator variable, $REFINANCE_{it}$ is included to account for this. There are important reasons why refinancing might reduce the propensity to choose an ARM. One is that in some states, refinanced loans are recourse loans, while purchase money loans are not, increasing the cost of default. As Campbell and Cocco (2003) showed, households with higher costs of default should be less inclined to choose ARMs. Additionally, if a household is refinancing, presumably they expect to be in the home long enough to recoup the costs, so they may be less likely to move in the near future.

Employment is an important consideration in the choice of mortgage contract, however it's not clear which contract an employed household will favor. While the

stable income provided by regular employment might make the lower payments of an ARM contract relatively more attractive, the more tightly binding liquidity constraints of an unemployed household head may push the household toward an ARM as well, so a higher level of housing consumption can be achieved. Additionally, retirement may have an effect on the choice of an ARM. Given the lower income during these years, and the expectation of a certain level of non-housing consumption, the potential for larger mortgage payments may be particulary distasteful. However, the relatively stable income of these years might make the initial savings of an ARM appealing. We will be agnostic about the effect of employment on mortgage choice, however, $EMPLOYED_{it}$ and $RETIRED_{it}$ will be included to account for their potential impact on the choice of mortgage contract type.

While the literature has shown little evidence that demographic factors have important effects on mortgage choice, it is not unreasonable to think that personal characteristics may influence the choice of an ARM vs. a fixed rate mortgage. Older borrowers could be less concerned with income variability, and households with children may be more concerned about risky payments, as they have to care for a larger family. Several demographic characteristics are added, including AGE_{it} and $AGE_{it}^2/100$, an indicator variable for the presence of children, $CHILDREN_{it}$, and the total number of children in the household. As well, an indicator for sex of the household head, taking a value of 1 if he is male, and a vector of indicator variables for marital status are added. The base case for marital status dummies is being a never-married household head.

Regression Results

Results for the main specification are in Table 1.4. It is important to remember that the within-estimator is being used and that these values should be interpreted as changes in *within* household propensity to choose an ARM with changes in the

dependent variables. In the most basic model, not including any variables besides measures of mortgage market participation and fixed effects, coefficients on the PM_{it}^{j} terms are positive, monotonically increasing, and marginally significant, with values of 5.3%, 10.2%, and 14.2%, respectively. These indicate that a household is, for example, 5.3 percentage points more likely to choose an adjustable rate mortgage when getting their second mortgage than they were on their first mortgage. This is within the same household. This is an important result, not previously documented. Previous participation mortgage markets increases the propensity to choose an adjustable rate mortgage when taking out a new mortgage. As demonstrated in the recent financial crisis, household mortgage activity can have significant effects on the wider economy, and it is important to understand how households make their home purchase financing decisions, and more broadly, how participation in financial markets affects household financial decision making.

As discussed earlier, borrower mobility has been shown in both a theoretical (Brueckner (1994), Campbell and Cocco (2003)) and empirical (Sa-Aadu and Sirmans (1995), Brueckner and Follain (1988), Dhillon et al. (1987)) context to influence the choice of an ARM versus an FRM. It is predicted that higher mobility should correlate with a higher propensity to choose an ARM. In the second model of Table 1.4, these measures of borrower mobility are included as $MAYBE\ MOVE_{it}$, $LIKELY\ MOVE_{it}$, $DEFINITELY\ MOVE_{it}$. We see that the propensity to choose an ARM is increasing in the self-reported probability of moving, as expected. To my knowledge, this is the first time that a borrower's directly reported probability of moving has been included in an analysis of the mortgage contract type decision. The magnitudes of the coefficients are similar in size and significance to those for mortgage market participation. Having recently moved is not an important factor when considering self-reported likelihood of moving, as shown by the lack of significance for the coefficient on $MOVED_{it}$. Importantly, the pattern for mortgage

Table 1.4: This table presents regression results for household fixed-effect models of mortgage choice. Coefficients should be interpreted as the change in the propensity to choose an adjustable rate mortgage, with a change in the dependent variable, within a household. For the measures of mortgage market participation, PM^j, coefficients represent the change in the propensity to choose an ARM within a household, relative to that households first mortgage choice. P-values for the coefficients are in parentheses, and use heteroskedastic robust and clustered standard errors.

	(1)	(2)	(3)	(4)	(5)	(6)
PM^2	**0.053**	**0.0753***	**0.0613**	**0.0642**	**0.0593**	**0.0860****
	(0.1557)	**(0.0632)**	**(0.1297)**	**(0.1086)**	**(0.1396)**	**(0.0475)**
$PM^{3,4}$	**0.1017***	**0.1324****	**0.1260****	**0.1285****	**0.1221****	**0.1359****
	(0.0669)	**(0.0256)**	**(0.0346)**	**(0.0289)**	**(0.0381)**	**(0.0266)**
PM^{5+}	**0.1419***	**0.2063****	**0.1938****	**0.2010****	**0.1888****	**0.2194*****
	(0.0615)	**(0.0108)**	**(0.0164)**	**(0.0122)**	**(0.0183)**	**(0.0059)**
MAYBE MOVE		0.1302***	0.1324***	0.1346***	0.1336***	0.1202***
		(0.0036)	(0.003)	(0.0025)	(0.0027)	(0.0084)
LIKELY MOVE		0.0932	0.1017	0.1005	0.104	0.1505**
		(0.2083)	(0.1643)	(0.1767)	(0.1519)	(0.0485)
DEFINITELY MOVE		0.1523***	0.1391**	0.1510***	0.1409**	0.1924***
		(0.006)	(0.0116)	(0.0061)	(0.0112)	(0.0005)
MOVED		-0.0108	-0.0219	-0.0261	-0.0228	-0.0272
		(0.7559)	(0.5218)	(0.445)	(0.5066)	(0.4394)
HVAL/INCOME			-0.0053		-0.006	-0.0036
			(0.4505)		(0.4592)	(0.7357)
TOTAL INCOME			-0.0002		-0.0002	-0.0001
			(0.4867)		(0.5381)	(0.7376)
INCOME/MPMT			0		0	-0.0001***
			(0.4137)		(0.3708)	(0.0001)
NET WORTH				0	0	0
				(0.952)	(0.6547)	(0.9409)
NW/HOUSE VALUE				-0.014	-0.0202	-0.0237
				(0.5105)	(0.3669)	(0.2655)
LOAN-TO-VALUE						-0.0636
						(0.757)
LOAN-TO-VALUE^2						0.1352
						(0.3274)
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.3706	0.391	0.4023	0.3985	0.4033	0.4389
N	4,164	3,920	3,856	3,883	3,856	3,694

market participation not only survives the inclusion of these measures of borrower mobility, but the pattern of increasing propensity to choose an adjustable rate mortgage with mortgage market participation is stronger, indicating it is not an artifact of borrowers with greater mobility generally having more experience in the mortgage market.

In model 3 of Table 1.4, measures of income and liquidity are included, non of which significantly affect the results presented in the first two columns. The same is true in column four, where household net worth and net worth relative to house value are included, in the absence of income measures. As well, including measures of income and net worth simultaneously does not affect our main result, that households are more likely to choose an ARM the more they have participated in mortgage markets. In the last column, loan-to-value and its value squared are included to measure how the amount of equity the household has in the home affects the borrowing decision. As discussed above, we would expect the loan-to-value ratio to have a negative relationship with the choice of an ARM, which is what we see, however the coefficient is not statistically significant. Interestingly, the only affordability measure that shows up significantly in the full model is $INCOME/PMT_{it}$, though the coefficient of a 100th of a percent is not economically significant. As well, coefficients on measures of borrower mobility are monotonically increasing in the borrower's likelihood of moving, with values of 12.0%, 15% and 19.2%, respectively, as we would expect. Finally, inclusion of loan-to-value measures strengthens the results about mortgage market participation, and we see that the coefficients on PM_{it}^{j} are now all statistically significant at the 5% level, with values of 8.6%, 13.6% and 21.9% for $j = 2, 3-4$, and 5+.

Unreported results on the impact of demographic variables on mortgage choice, included in Table 1.4 as "Demographics", the head of the household changing from a woman to a man, as in the case of a marriage, results in a significant increase in the

propensity to choose an ARM (30%). There is a significant quadratic relationship between ARM choice propensity and age, with coefficients on AGE_{it} and $AGE_{it}^2/100$ of -5.53% and 6.13% respectively. This is a slight "U" shaped pattern, with the general effect of age decreasing the propensity to choose an ARM. To my knowledge, the effects of age on mortgage choice have not been documented previously. Finally, a change in the marital status, relative to a never-married single, to $MARRIED_{it}$ increases the propensity to choose an ARM. This is most likely the result of increased labor market flexibility, on average. A single income household with two people will have the option for the second, non-working individual, to enter the labor market in the event of an increase in interest rates. As well, a household's marital status changing to $SEPARATED$ has a significant positive coefficient. This could reflect a more tightly binding liquidity or budget constraints of halving wealth and income in the event of a divorce, pushing households toward the lower initial payments of ARMs. This is consistent with Deng, Quigley, and Order (2000) finding "trigger" events (such as divorce or separation) being important in the default and prepayment behavior of households. Further investigation of marital status and its interaction with mortgage choice is left for future work. These results are largely consistent with previous analysis, which showed that borrower mobility is one of the most important individual factors on the contract type decision. However, the increased propensity to choose an ARM with mortgage market participation has not been documented before. Below, we will discuss some potential explanations for this pattern.

Liquidity and Budget Constraints

We know that wealth and income are both important considerations when choosing a mortgage. Theory suggests that both factors should have a positive relationship with the propensity to choose an ARM. While net worth and income are included in the main specification, we could ask if the observed pattern of increased propensity

to choose an ARM increasing with participation in the mortgage market can be explained by income or wealth increasing at the same time. In Table 1.5, regressions are presented interacting net worth and income terciles for mortgage originators in the year in which the mortgage was taken out, with number of mortgages. The main specification is also included for comparison. Looking first at the second column, we see that though the strength of the pattern is different over the wealth distribution, the overall pattern holds. Propensity to use an ARM increases the most in the first and second terciles. In the lowest quantile, the coefficient on PM_{it}^2 is large, at 13.4%, and statistically significant. With four or more previous mortgages, the propensity to choose an adjustable rate mortgage is 25.3 percentage points larger than when taking out a first mortgage for a household in the lowest net worth tercile. In the top wealth quantile, the pattern persists, though it is less pronounced and not statistically significant.

This difference between the top tercile of net worth and the rest of the net worth distribution seems to have two main drivers. First, households in the top tercile of net worth, but not in the top tercile of income, do not seem to increase their usage of ARMs. This can be seen in Table 1.6, Panel (B), by the negative coefficients on the interaction terms between $INC_{it}^{1,2}$, which indicates a household belonged to the first or second tercile of income, but to the top tercile of net worth, and PM_{it}^j. All coefficients are from the same regression with interactions being row variables interacted with column variables. They are not statistically significant, however the relatively few number of households with high net worth and lower income does not allow a very precise estimate. Households with high net worth, but relatively lower income still have a house value similar to their high net worth peers (roughly 55% of net worth). Since they have similarly large homes but lower income, these households are much more exposed to negative interest movements. In the event of interest rates increase, they might have to liquidate assets, or default on the

Table 1.5: This table gives estimates for changes in within household propensity to choose an ARM with mortgage market participation interacted with wealth and income distribution, as well as the main specification for comparison. Standard errors are in parentheses, with p-values beneath them. The dependent variable, ARMit, is an indicator variable taking the value one if the household chose an adjustable rate mortgage. * indicates significance at the 10% level, ** at the 5% level and *** at the 1% level.

	Main		Net Worth		Income
Dependent Variable	ARM_{it}		ARM_{it}		ARM_{it}
PM^2	0.0860**	$NW^1_{it}*PM^2$	0.1340***	$INC^1_{it}*PM^2$	0.0395
	(0.0434)		(0.049)		(0.0553)
	0.0475		0.0063		0.4759
$PM^{3,4}$	0.1359**	$NW^1_{it}*PM^{3,4}$	0.1880***	$INC^1_{it}*PM^{3,4}$	0.1683**
	(0.0613)		(0.07)		(0.0732)
	0.0266		0.0073		0.0216
PM^{5+}	0.2194***	$NW^1_{it}*PM^{5+}$	0.2531**	$INC^1_{it}*PM^{5+}$	0.2022**
	(0.0797)		(0.1071)		(0.1029)
	0.0059		0.0182		0.0496
		$NW^2_{it}*PM^2$	0.0682	$INC^2_{it}*PM^2$	0.0669
			(0.0561)		(0.0462)
			0.2245		0.1482
		$NW^2_{it}*PM^{3,4}$	0.1162*	$INC^2_{it}*PM^{3,4}$	0.1224*
			(0.0658)		(0.0649)
			0.0775		0.0596
		$NW^2_{it}*PM^{5+}$	0.2466***	$INC^2_{it}*PM^{5+}$	0.2242***
			(0.088)		(0.0861)
			0.0051		0.0093
		$NW^3_{it}*PM^2$	0.0127	$INC^3_{it}*PM^2$	0.1398**
			(0.0582)		(0.0603)
			0.8267		0.0206
		$NW^3_{it}*PM^{3,4}$	0.0652	$INC^3_{it}*PM^{3,4}$	0.1239*
			(0.0708)		(0.0686)
			0.3578		0.071
		$NW^3_{it}*PM^{5+}$	0.126	$INC^3_{it}*PM^{5+}$	0.2122**
			(0.0892)		(0.0887)
			0.158		0.0167
Controls	Yes		Yes		Yes
HH Fixed Effects	Yes		Yes		Yes
Region Controls	Yes		Yes		Yes
Time Fixed Effects	Yes		Yes		Yes
Industry Fixed Effects	Yes		Yes		Yes
Time*Industry FE	Yes		Yes		Yes
R^2	43.89%		44.60%		44.36%
N	3,694		3,689		3,689

home. These are outcomes their peers with higher income do not have, and they are consequently much less inclined to use adjustable rate mortgages.

Second, homeowners who were of an age to buy their first home in the early 1980s, when ARMs were first introduced to the American market and interest rates increased sharply (peaking at over 16% for 1 year t-bills) seem to have been turned off to ARMs. It is likely many of them used adjustable rate mortgages (two thirds of mortgages originated in 1984 were ARMs (Brueckner and Follain, 1988)) and were financially exposed to the high and variable interest rates of the 1980s. The interaction of BUY^{80}, which indicates a homeowner was 25 or older in 1980, and the PM_{it}^{j} terms also have negative coefficients, indicating that on average these households do not increase their usage of ARMs. It should be noted that coefficients are not statistically significant, however the relatively few number of observations who were buyers in 1980 and are observed with a large number of mortgages, where the effect should be most pronounced, is relatively small. Importantly, once these two affects are properly controlled for, the third tercile of wealth exhibits the same behavior as the other two terciles. The coefficient on the interaction of NW_{it}^{3} and PM_{it}^{3} is approximately 0.28, vs 0.33 and 0.30 for $PM_{it}^{3,4}$ and PM_{it}^{2}, respectively, and statistically significant at the 5% level. Coefficients are similar in magnitude on other interaction terms across net worth terciles. Tests of the null hypothesis that coefficient estimates are equal across net worth quantiles cannot be rejected.

Another possible explanation for the increasing usage of ARMs with mortgage market participation is more tightly binding liquidity constraints. If lower income households are moving more frequently to chase jobs, this might be driving the observed results. However, the interaction of income and participation shows a similar pattern to that of wealth and participation. The second column of Table 1.5 shows the distribution of income for new mortgagees interacted with the measures of mortgage market participation. Column 3 of Table 1.5 shows that for each tercile of

Table 1.6: This table shows how households with a high net worth differ in their mortgage choice decisions. It reports point estimates with p-values in parentheses beneath. Panel (A) displays the net worth regression from Table 1.5, but including indicator variables for belonging to the second and third terciles of net worth, for convenience and comparison. Panel (B) repeats the analysis, but includes interaction terms for households how have a high net worth, but low income, and households who were likely buying their first home in the early 1980s. Please see the text for a detailed discussion of these variables and results. * indicates significance at the 10% level, ** at the 5% level and *** at the 1% level.

Panel A

	PM^{2}	$PM^{3,4}$	PM^{5+}
NW^{1}_{it}	0.1269**	0.1778**	0.2407**
	(0.0243)	(0.0244)	(0.0322)
NW^{2}_{it}	0.0695	0.1152	0.2433***
	(0.2382)	(0.1014)	(0.0075)
NW^{3}_{it}	0.0369	0.0912	0.152
	(0.6914)	(0.3689)	(0.1899)

Panel B

	PM^{2}	$PM^{3,4}$	PM^{5+}
NW^{1}_{it}	0.1403**	0.2021**	0.3044***
	(0.0101)	(0.0158)	(0.0079)
NW^{2}_{it}	0.0835	0.1461**	0.3283***
	(0.1406)	(0.0417)	(0.0014)
NW^{3}_{it}	0.0464	0.1586	0.2873**
	(0.6902)	(0.1776)	(0.0297)
$INC^{1,2}_{it}*NW^{3}_{it}$	-0.0292	-0.1465	-0.1714
	(0.8772)	(0.4382)	(0.3746)
BUY^{80}	0.0044	-0.0268	-0.1772
	(0.9736)	(0.8683)	(0.3257)

income, participation is positively related to choosing an ARM. Estimates for the coefficient on PM_{it}^2 range from 3.95 percentage points in the lowest income quantile to 14 percentage points higher for the largest income quantile. The propensity to choose an ARM increases with the number of previous mortgages used, our measure of mortgage market participation, uniformly across the entire income distribution. If more tightly binding liquidity constraints for households with more extensive experience in the mortgage market were driving results, we would not expect the propensity to choose an ARM to be increasing with participation in the higher quantiles of income.

While the propensity to choose an ARM increases across all three terciles of income and wealth, the cutoffs for being in the third tercile of net worth and income are $192 thousand and $102 thousand, respectively. It is unlikely that all households in the top terciles are unconstrained in their optimal choice of housing consumption. However, we can look at those at the extreme tails of the distribution. Table 1.7 presents results for households we will term "unconstrained." The first column includes interactions of an indicator variable equal to 1 if the household has a net worth greater than $750 thousand, which translates to the 92^{nd} percentile of the wealth distribution, with the measures of mortgage market participation. The coefficients on the interaction terms are small and statistically insignificant, indicating that very wealthy households, which are unlikely to be constrained by wealth, do not behave differently from the rest of the population. Similar results were obtained for a net worth of $1.25 million, which translates to the 95^{th} percentile.

The second column of Table 1.7 shows regression results for a comparable analysis of high income households. Here, the indicator variable in the interaction terms is 1 if total household income is greater than $300 thousand, which translates to the 98^{th} percentile of the wealth distribution. Again, the coefficients on the interaction terms are small and insignificant, indicating households which are not constrained

Table 1.7: This table presents fixed-effect regression results for households with net worth greater than $750,000, income greater than $300,000 and with a net worth to house value ratio greater than 2.8. These households represent those least likely to be constrained when they make their housing consumption decision. Column 5 includes interaction terms for mortgage market participation and an indicator if the respondent moved and the new house is greater than 2.7 times the value of the old house. The last column interacts an indicator if the respondent indicated they moved to get a "better"home, either in terms of physical plant or location. Controls, region effects, time effects and the interaction of time and industry effects are included in all regressions. Please see the text for a detailed discussion of these variables. P-values are in parentheses below point estimates. * indicates significane at the 10% level, ** at the 5% level and *** indicates significance at the 1% level.

Interaction	NW > $750K	INC > $300K	NW/HVAL > 2.8	PMT/INC < 8.5%	HI > 2.7	BETTER HOME
Dependent Variable	ARM_{it}	ARM_{it}	ARM_{it}	ARM_{it}	ARM_{it}	ARM_{it}
PM^2	0.0895**	0.0897**	0.0835*	0.0815*	0.0681*	0.0932**
	(0.0391)	(0.0383)	(0.0561)	(0.065)	(0.0946)	(0.0364)
$PM^{3,4}$	0.1340**	0.1367**	0.1289**	0.1354**	0.1025*	0.1525**
	(0.0318)	(0.0263)	(0.036)	(0.0277)	(0.065)	(0.0177)
PM^{5+}	0.2246***	0.2256***	0.2082***	0.2250***	0.1946***	0.2395***
	(0.0064)	(0.0053)	(0.0093)	(0.0059)	(0.0066)	(0.0028)
$IND_{it}*PM^2$	-0.084	-0.0742	-0.1425	0.1061	-0.0253	0.0145
	(0.4303)	(0.5898)	(0.2701)	(0.2673)	(0.6402)	(0.7954)
$IND_{it}*PM^{3,4}$	0.0337	0.0546	-0.0447	0.0794	0.5494***	-0.0366
	(0.6444)	(0.6084)	(0.7773)	(0.33)	(0)	(0.5419)
$IND_{it}*PM^{5+}$	-0.0408	-0.0342	0.0677	0.038	0.8571***	-0.3044***
	(0.6984)	(0.8169)	(0.5762)	(0.6599)	(0)	(0.0024)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Region Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time*Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	43.99%	43.98%	44.00%	44.18%	47.38%	44.30%
N	3,694	3,694	3,694	3,694	3,694	3,694

by income in their choice of housing consumption do not behave differently than the rest of the population. They also have an increased propensity to choose ARMs with increasing participation in mortgage markets.

Columns three and four of Table 1.7 present regressions for ratios of wealth to house value and mortgage payments to income, respectively. In column three, an indicator variable taking a value of 1 if the ratio of net worth to house value is greater than 2.7, which corresponds to the 90^{th} percentile, is interacted with the number of previous mortgages, as before. The coefficients on the interaction terms are not statistically significant and are monotonically increasing. These unconstrained house-

holds exhibit the same pattern of increasing usage of ARMs with mortgage market participation, but potentially at a different rate, as the relatively more constrained households. Column four interaction terms include an indicator variable equal to 1 if the ratio of housing expenses, defined to be the sum of mortgage payments, real estate taxes, and homeowners insurance, to the mean of 5 year lagged income is less than 10.8%, corresponding to the 15^{th} percentile of the distribution of this ratio. Mortgage underwriting standards mandate that the ratio of housing costs to income should be 28% or less. Households with relatively low ratios of housing expense to income could most likely afford a larger home and were probably unconstrained in their choice of housing consumption. Coefficients on the interaction terms are not statistically significant. Moreover, if we add coefficients on interaction terms and raw mortgage market participation variables, we get 18.75%, 21.5% and 26.3% for 2, 3-4 and 5+ previous mortgages, respectively, showing increasing usage of ARMs with mortgage market participation for these unconstrained households as well, and demonstrating this phenomenon is not confined to households with binding budget or liquidity constraints.

The final two columns of Table 1.7 investigate the propensity of households who are significantly increasing their housing consumption in terms of value of home, and also those who moved to get a better home, either in terms of physical plant or location. Column 5 interacts an indicator variable, HI_{it}, equal to 1 if the value of the household's new home is 3.1 (90^{th} percentile) times or more than the value of its previous home. Presumably, households with large increases in housing consumption are more likely to be constrained, and potentially more likely to use ARMs as result. We find that this is the case, with those who increase their housing consumption significantly having a much higher propensity to choose ARMs. Importantly, though, we see the propensity to choose ARMs increasing in mortgage market participation for both those with significantly larger housing consumption and those with less

extreme changes in consumption. Results for the 50^{th} and 75^{th} percentiles are similar.

Following a similar argument to that for column 5, if households are expanding their housing consumption immediately upon being able to afford a larger or better home, and bumping into budget or liquidity constraints as a result, we would expect those who report they moved to get a larger, better or more optimally located home to be driving the results presented above. In column 6, an indicator variable taking the value of 1 if the household responds that they moved to get a better house, either in terms of physical characteristics of the home, or location. The PSID asks the question "Why did you move?" if the household responded that they moved. Choices included changing jobs, moving closer to work, responses to involuntary events, and marriage. Respondents could also reply, "expansion of housing: more space; more rent; better place" or "neighborhood related: better neighborhood; go to school; to be closer to friends/relatives." If the respondent gave either of these answers, the variable $BETTER\ HOME_{it}$ was assigned a value of 1. Looking at the coefficients in column 6, we see that the interaction terms are small and not significant for all but the last term. More importantly, the documented phenomenon of increasing propensity to choose an adjustable rate contract with mortgage market participation persists for those who are refinancing or moving for other reasons. Similar results were obtained for either response alone, and for a restricted sample which included only households which moved.

We might also be concerned that households living in areas with increasing housing prices, such as the Southwest and California, are being priced out of fixed rate contracts. The sample includes a time period of rapid growth in house prices across the country. If this is the case, we would expect households not in these high growth areas to exhibit different behavior. Table 1.8 presents coefficient estimates for two models. In column 1, an indicator variable taking a value of 1 if the state in which the household resides has seen home prices increase by 40% or more in the previous

five years, as calculated from the Federal Housing Finance Association's state level housing price indexes. This translates to an approximately 7% per year increase, on average. While it seems that households in these states increase their usage of ARMs more rapidly, we also see that those not in high priced states exhibit the same behavior, refuting the argument that households are being priced out of FRMs by rising home prices. Similar results were obtained for 50% (8.5% annualized) growth in prices over 5 years. Additionally, the second column presents our main specification, restricted to years after 2005, a period marked by falling home prices. We see the pattern persists, also inconsistent with rising home prices, inducing homeowners to use lower cost ARMs.

The wealth and income results, and those pertaining to financial constraints, are inconsistent with budget or liquidity constraints driving the increased usage of ARMs with participation in mortgage markets. However, it could be the volatility of income that matters, and not the level. This is a possibility discussed below.

Income Volatility

Income volatility should be one of the most important predictors of ARM choice propensity. As Campbell and Cocco (2003) showed, adjustable rate contracts should be less appealing for households with a large volatility of income, as it is more likely that periods of high interest rates and low income will coincide. It could be that as households participate in mortgage markets, their incomes become more stable. If this is the case, we would expect the trend of increased propensity to choose an ARM with mortgage market participation to disappear for households with unstable income. That is, if a household has an unstable income, we should not see the pattern of increasing usage of ARMs with more extensive participation in mortgage markets. In a regression context, this is equivalent to saying the coefficients on our measures of mortgage market participation should not be positive or increasing for households

Table 1.8: This table presents results for high housing price growth areas and a restriction of the sample period to post 2005, when real estate values fell across the country. The indicator variable in the first column indicates 5 year real estate price growth of 40% or higher. Please see the text for a detailed discussion of these variables. P-values are in parentheses below point estimates. * indicates significane at the 10% level, ** at the 5% level and *** indicates significance at the 1% level.

Interaction	5-yr Price Growth > 40%	After 2005
Dependent Variable	ARM_{it}	ARM_{it}
PM^2	0.0561	0.1420**
	(0.205)	(0.0177)
$PM^{3,4}$	0.1082*	0.2373***
	(0.0951)	(0.0051)
PM^{5+}	0.1820**	0.3162***
	(0.0351)	(0.0011)
$IND_{it}*PM^2$	0.0874*	
	(0.0644)	
$IND_{it}*PM^{3,4}$	0.0572	
	(0.1755)	
$IND_{it}*PM^{5+}$	0.1147	
	(0.1136)	
Controls	Yes	Yes
Region Controls	Yes	Yes
Time Fixed Effects	Yes	Yes
Time*Industry FE	Yes	Yes
R^2	44.38%	50.72%
N	3,694	2,883

with high volatility of income growth. Results are reported in Table 1.9. In column 2, results are shown using the standard deviation of trailing earnings growth for the previous five years. An indicator variable, IV_{it}^{L} for being in the top quintile of income growth volatility in a year when a mortgage is taken out, is interacted with the measures of mortgage market participation. Here $L = HIGH\ IV$. If the null hypothesis that household income is becoming more stable with time, reducing the income risk of ARMs, is true, then increasing propensity to choose an ARM with mortgage market participation is expected to disappear among those with high income volatility. That is, the coefficients on the interaction terms should be negative and significantly different from zero. Only one of these coefficients is negative and none are significant, showing that the propensity to choose an ARM increases with participation in mortgage markets even for high income volatility households. This contradicts the hypothesis that incomes become more stable simultaneously as mortgage market participation increases. Results are qualitatively unchanged when redefining the high income volatility households as the top 10% or top 30% of the income growth volatility distribution.

Alternatively, we could look at the low end of the distribution of income volatility. If households with stable incomes are driving results, we would expect the pattern of increased propensity to choose an ARM to disappear for those not in the lower part of the income volatility distribution. That is, coefficients on the mortgage market participation indicators should not increase monotonically as j increases. In column 3 of Table 1.9, the same measure of income growth volatility is used, however now an indicator variable is added if the income volatility is in the lowest 30% of the distribution ($L = LOW\ IV$). We lose some power due to observation attrition, but we see the coefficients on the interaction terms are close to zero and not statistically significant, while the coefficients on the PM_{it}^{j} terms are very similar in magnitude and significance to previous results. This shows that these households do not behave

Table 1.9: This table shows regression results investigating income volatility as a driver for the result that the propensity to choose an adjustable rate mortgage increases with previous participation in mortgage markets. The first column presents the main result for comparison, while the second separates out those households in the highest quintile of income volatility. The third column separates out households in the lowest quintile of income volatility and the final column separates out households in the top quintile of income trend. Please see the text for a detailed discussion of these variables. P-values are in parentheses below point estimates. * indicates significane at the 10% level, ** at the 5% level and *** indicates significance at the 1% level.

	Main	Lagged IV: High	Lagged IV: Low	IV Time Trend
	ARM_{it}	ARM_{it}	ARM_{it}	ARM_{it}
PM^2	0.0860**	0.0123	0.0197	0.0038
	0.0475	0.7996	0.7267	0.9417
$PM^{3,4}$	0.1359**	0.0869	0.0823	0.0818
	0.0266	0.2141	0.2567	0.271
PM^{5+}	0.2194***	0.1657*	0.1609*	0.1936**
	0.0059	0.0675	0.0834	0.0464
$IV^L_{it}*PM^2$		0.1025	0.0292	0.1800**
		0.1577	0.6165	0.0166
$IV^L_{it}*PM^{3,4}$		-0.0894	-0.0392	0.0451
		0.1232	0.2614	0.4525
$IV^L_{it}*PM^{5+}$		0.1177	-0.0028	-0.0204
		0.1763	0.9582	0.7912
Controls	Yes	Yes	Yes	Yes
R^2	43.89%	48.38%	48.38%	48.94%
N	3,694	2,889	2,889	2,893

markedly different from those with higher income volatility, and increasing income stability with participation in mortgage markets is not causing the observed increase in propensity to use ARMs. Results are qualitatively similar if the definition of low income volatility is changed to the lowest 20% of the distribution.

Another measure of cash flow volatility is the OLS regression coefficient of income growth on time, β_{INC}. This variable has the advantage of measuring directionality of income changes. Presumably households with recent growth in income will expect similar growth in the future, and will be in a better position to weather any unfavorable interest rate environments. Households with large and positive income growth should be more apt to choose an ARM, as they expect future income growth to be positive as well. If income growth is more likely to be positive at the same time as mortgage market participation increases, we would see the observed increases in ARM choice propensity. Assigning the value of IV_{it}^{L}, $L = \beta_{INC}$ to be one when a household's β_{INC} is in the top quintile of all households and interacting IV_{it}^{L} with our PM_{it}^{j} variables, we include these in the same manner as before. Looking at the fourth column of Table 1.9, we see the propensity to choose an ARM is unchanged for households with a high β_{INC}, except for early in the experience with mortgage markets, with coefficients on the interaction terms ranging from 18% and significant at the 5% level for one previous mortgage, to -2% and not significant for four or more previous mortgages. We see that for the rest of the sample, coefficients on mortgage market participation are largely unchanged, contrary to the hypothesis that large income growth is driving this phenomenon.

Confounding

The potential for confounding effects of other variables is present in any regression analysis. I have tried in this section to address the largest potential confounding effect in the context of this study: households making housing decisions for non-

housing related reason. In this section, I will be investigating if households who are potentially removing equity from their home in order to pay for extreme expenses might be driving the overall result that the propensity to choose and adjustable rate mortgage increases with participation in mortgage markets.

One of the primary reasons a household might extract equity is because it is an entrepreneurial one in which home equity is required to invest in the "family" business. In the PSID, data are obtained indicating weather the head of the household is self employed. An indicator variable ($SELFEMP^t$) if the household head is self employed is interacted with the measures of mortgage market participation. Results are presented in the first column of Table 1.10. We see that self employed households may not increase their usage of ARMs as soon as other households, as indicated by the marginally significant coefficient of -13.75% on the interaction with PM^2, but importantly, this effect is not driving the general result. As well, self employed seem to exhibit the same pattern, with the possible exception discussed above.

A second reason a household might extract equity is that a child or children might be attending, or about to attend, college. The PSID does not provide data exactly covering if dependents are in college, but we can see the age of the youngest child. I condition on the youngest child in the household being over 15 with the idea that if the youngest child is 15, either she will soon be in college and any siblings will either be in college, or be in college in the near future as well. Results are presented in column 2 of Table 1.10. An indicator variable taking a value of one if the youngest child is over 15 ($CHILD^{15}$) is interacted with measures of mortgage market participation. Coefficients on the interacted terms are universally insignificant, and the main pattern continues to hold. This analysis was repeated for the youngest childe being older than 16 and 17, with similar outcomes. Results are consistent with children nearing, or in, college not confounding the main result.

The PSID also directly measures school expenses. This could be for a child's

college tuition, as above, or for a household head's own education. Creating an indicator for high school expenses relative to income ($SEI^{0.2}$), which takes a value of one if school expenses exceed 20% of total household income, interactions with the mortgage market participation variables are created. Column 3 of Table 1.10 presents results. Coefficients on interaction terms are universally statistically insignificant, though the magnitude on $SEI^{0.2}$ interacted with PM^2 is relatively high, suggesting households might be switching to ARMs early in their dealings with the mortgage market. Importantly, however, the general result that households have an increased propensity to use ARMs with mortgage market participation is not significantly influenced by accounting for high school expense.

Household heads who spend a large amount of time away from work due to illness or unemployment might pull equity out of the home to pay for daily expenses. Additionally, they might find it more difficult to qualify for a loan, pushing them toward adjustable rate products. The PSID includes data on time spent away from work due to illness or unemployment, and indicator variables are created taking a value of one of the household head was away from work for at least a month in the previous year. The last two columns of Table 1.10 present results where an indicator variable for a large amount of time spent ill ($ILLTIME^{30}$) or spent unemployed ($UEMPTIME^{30}$) is interacted with measures of mortgage market participation. Results are similar in both cases, with significant interaction terms with PM^2 in both cases, and with $PM^{3,4}$ in the case of $UEMPTIME^{30}$. This indicates households may be pushed to ARMs to some degree by the difficulties of unemployment, whether for medical reasons or otherwise. It is important to note, however, that the main results continue to hold, if with a slightly lower level significance for PM^2 and $PM^{3,4}$ than before. This is consistent with unexpected expense having an effect on housing choices, but not driving the main result that households increase their usage of adjustable rate mortgages as the participate in the mortgage market.

Table 1.10: This table shows regression results investigating potentially confounding effects due to households potentially removing equity from their home in order to pay for certain extreme expenses. This includes self-employment ($SELFEMP^t$), children in or soon to be in college ($CHILD^{15}$), large school expenses relative to income ($SEI^{0.2}$), a large amount of time spent ill and unable to work ($ILLTIME^{30}$) or a large amount of time spent unemployed ($UEMPTIME^{30}$). Indicator variable interacted with measures of mortgage market participation is indicated at the top of each column. Please see the text for a detailed discussion of these variables. P-values are in parentheses below point estimates. * indicates significane at the 10% level, ** at the 5% level and *** indicates significance at the 1% level.

	SELF EMP^t	CHILD^{15}	SEI$^{0.2}$	ILLTIME^{30}	UEMPTIME^{30}
PM^2	0.1052**	0.0865**	0.0843*	0.0658	0.0624
	(0.0355)	(0.0488)	(0.0553)	(0.1644)	(0.1794)
PM^{3,4}	0.1649**	0.1329**	0.1357**	0.1324*	0.1178*
	(0.0215)	(0.0314)	(0.0281)	(0.0502)	(0.077)
PM^{5+}	0.2438***	0.2244***	0.2205***	0.2158***	0.2050**
	(0.006)	(0.0052)	(0.0062)	(0.0096)	(0.0126)
IND$_{it}$*PM^2	-0.1375*	0.0188	0.2797	0.1635**	0.1730**
	(0.0971)	(0.8566)	(0.1341)	(0.0458)	(0.0219)
IND$_{it}$*PM^{3,4}	0.0455	0.0417	-0.0856	0.0781	0.1247*
	(0.5423)	(0.5058)	(0.5142)	(0.3291)	(0.0782)
IND$_{it}$*PM^{5+}	0.1285	-0.0889	-0.0761	0.0704	-
	(0.3362)	(0.1777)	(0.5894)	(0.3974)	-
Controls	Yes	Yes	Yes	Yes	Yes
R^2	45.9%	44.1%	44.1%	44.5%	44.3%
N	3,313	3,694	3,665	3,694	3,694

Composition

It is possible that households who reach 5 or more mortgages in the sample period are systematically different than households who only reach 3 or 4 mortgages, who may in turn differ significantly from households who reach only 2 mortgages in the sample. Table 1.11 presents means for relevant variables by year, maximum number of mortgage reached in the sample, and number of mortgages reached by each year. There appear to be few differences across categories. Table 1.12 presents major financial and demographic variables across different max mortgage groups (MM^2, $MM^{3,4}$ and MM^{5+}), with equal number of mortgages, across time. That is, I com-

pared MM^2 and $MM^{3,4}$, where current number of mortgages was 2, at each year from 1999-2009. I did the same for current mortgages of 3 or 4 and compared $MM^{3,4}$ and MM^{5+}. Comparing means for MM^2 and $MM^{3,4}$ indicates few differences overall. Possibly lower income for the MM^2 group, but the MM^2 group has the same, or perhaps slightly higher, income/housing expense ratio, with some years being higher and some years lower. The other potential difference is the MM^2 group is less likely to have a male head. All these considerations are controlled for in the regression and based on this type of summary statistic there appears to be little difference. Medians show a similar pattern. Comparing $MM^{3,4}$ and MM^{5+}, each with 3 or 4 mortgages, across years shows little systematic difference. Some years $MM^{3,4}$ has higher income or net worth and other years MM^{5+} has higher values for these variables. When not conditioning on comparing groups with the same number of mortgages, MM^2 seems to have systematically lower income and net worth, but this makes sense as they never reach more than 2 mortgages and are likely to be earlier in their life cycle, with less chance for wealth accumulation and income growth.

In Table **??**, Panel (A) presents the distribution of observations over the different maximum mortgages categories, by year. We see that, overall, the distribution is fairly constant. Households belonging to MM^2 tend to comprise approximately 30% of the sample in any given year, while $MM^{3,4}$ and MM^{5+} households account for about 55% and just under 20%, respectively. This shows that there are not truncation issues, with most of the MM^2 households clustering near the end of the sample, but in fact the distribution across years is roughly stable. Panel (B) of Table 1.12 presents the distribution of maximum mortgage categories across industry of employment for the head of the household. In general, the distribution is relatively consistent across MM^2, $MM^{3,4}$ and MM^{5+}). Notable exceptions are that MM^2 households seem to be have a lower percentage of households in manufacturing and a higher percentage of households in retail, relative to the other categories. However, they are more similar

Table 1.11: This table presents means for relevant financial, economic and demographic variables separated by year, maximum number of mortgages reached in the sample, and the mortgages reached at each point in time. Panel (A) compares households who achieve a maximum of 2 mortgages with those who reach 3 or 4 mortgages, while Panel (B) compares households who achieve a maximum of 3 or 4 mortgages with those achieve a maximum of 5 or more mortgages.

Panel A: Means - MM^{2}-$MM^{3,4}$, Total Mortgages 2

	1999		2001		2003		2005		2007		2009	
	MM = 2	MM = 3,4	MM = 2	MM = 3,4	MM = 2	MM = 3,4	MM = 2	MM = 3,4	MM = 2	MM = 3,4	MM = 2	MM = 3,4
MAYBE MOVE	0.98	0.85	0.81	0.88	0.88	0.92	0.85	0.88	0.76	0.86	0.78	-
LIKELY MOVE	0.01	-	-	-	0.02	0.06	0.01	0.06	0.08	0.05	0.06	-
DEFINITELY MOVE	-	0.12	0.06	0.12	0.06	0.02	0.05	0.06	0.12	0.05	0.12	-
MOVED	0.57	0.54	0.49	0.65	0.37	0.34	0.46	0.40	0.50	0.46	0.50	-
REFINANCE	0.30	0.31	0.21	0.24	0.70	0.74	0.45	0.56	0.46	0.52	0.45	-
CHILDREN	0.29	0.53	0.62	0.61	0.44	0.54	0.57	0.52	0.50	0.67	0.44	-
TOTAL INCOME	76.27	83.57	55.23	119.00	79.93	87.12	78.69	100.67	75.07	101.63	96.64	-
LOAN-TO-VALUE	0.60	0.83	0.77	0.68	0.69	0.67	0.63	0.58	0.73	0.69	0.73	-
LOAN-TO-VALUE^2	0.42	0.73	0.64	0.51	0.53	0.49	0.45	0.36	0.58	0.52	0.62	-
MALE	0.65	0.69	0.87	0.95	0.60	0.71	0.78	0.94	0.77	0.83	0.76	-
INCOME/MPMT	10.66	6.17	6.31	8.43	6.84	7.07	8.62	6.01	6.41	5.83	9.23	-
NET WORTH	140.44	216.21	179.36	173.41	167.61	140.32	234.50	248.05	134.18	230.23	219.01	-
NW/HOUSE VALUE	0.82	1.14	0.66	0.80	0.80	0.67	0.84	0.75	0.57	0.63	0.88	-
AGE	49.86	41.29	47.13	44.53	44.92	39.07	42.93	39.87	38.40	37.87	43.49	-
AGE^2/100	25.97	17.82	23.94	20.61	21.96	16.34	20.23	17.09	15.80	15.17	20.89	-
NUM CHILDREN	0.55	0.91	1.17	1.32	0.73	1.03	0.99	1.02	0.98	1.12	0.81	-
EMPLOYED	0.70	0.91	0.66	0.89	0.89	0.88	0.81	0.87	0.85	0.95	0.81	-
RETIRED	0.20	0.09	0.28	-	0.09	0.06	0.15	0.12	0.06	0.03	0.09	-
DIVORCED	0.33	0.27	0.15	-	0.28	0.16	0.14	0.05	0.19	0.13	0.18	-
WIDOWED	0.05	0.06	0.13	0.05	0.10	-	0.09	0.06	0.01	0.06	0.06	-
MARRIED	0.60	0.53	0.72	0.95	0.46	0.67	0.67	0.85	0.61	0.66	0.62	-
SEPARATED	-	-	-	-	-	0.00	0.02	-	0.01	0.02	0.01	-

Panel B: Means - $MM^{3,4}$-MM^{5+}, Total Mortgages 3 or 4

	1999		2001		2003		2005		2007		2009	
	MM = 3,4	MM = 5+	MM = 3,4	MM = 5+	MM = 3,4	MM = 5+	MM = 3,4	MM = 5+	MM = 3,4	MM = 5+	MM = 3,4	MM = 5+
MAYBE MOVE	0.92	0.81	0.96	0.81	0.91	0.82	0.90	0.92	0.83	0.81	0.85	-
LIKELY MOVE	-	0.03	-	0.05	0.01	0.02	0.03	-	0.04	0.06	0.03	-
DEFINITELY MOVE	-	0.09	0.04	0.06	0.04	0.04	0.05	0.08	0.07	0.05	0.05	-
MOVED	0.30	0.42	0.55	0.54	0.27	0.21	0.37	0.17	0.39	0.39	0.26	-
REFINANCE	0.77	0.58	0.50	0.30	0.75	0.86	0.61	0.69	0.53	0.58	0.67	-
CHILDREN	0.39	0.47	0.54	0.49	0.38	0.35	0.44	0.46	0.46	0.39	0.54	-
TOTAL INCOME	126.38	119.58	102.28	115.40	124.23	141.82	113.40	111.24	97.93	109.78	110.37	-
LOAN-TO-VALUE	0.62	0.76	0.64	0.54	0.57	0.59	0.57	0.57	0.61	0.59	0.69	-
LOAN-TO-VALUE^2	0.44	0.64	0.45	0.35	0.37	0.39	0.38	0.36	0.43	0.40	0.57	-
MALE	0.95	0.78	0.84	1.00	0.88	0.90	0.88	1.00	0.86	0.82	0.87	-
INCOME/MPMT	8.52	8.29	7.91	8.24	9.23	7.62	8.02	6.96	7.79	7.14	8.32	-
NET WORTH	413.64	225.49	227.15	363.68	438.45	479.31	413.11	250.63	297.69	391.96	316.63	-
NW/HOUSE VALUE	1.39	1.11	0.92	1.01	1.33	1.13	1.09	0.77	0.88	0.99	1.04	-
AGE	49.40	44.50	47.04	45.86	51.27	50.13	46.96	49.59	47.35	52.49	47.45	-
AGE^2/100	25.45	20.25	23.04	22.06	27.41	26.04	23.20	25.46	23.80	29.22	24.00	-
NUM CHILDREN	0.75	0.99	1.02	0.99	0.71	0.74	0.84	0.74	0.90	0.84	0.99	-
EMPLOYED	0.89	0.91	0.83	0.72	0.86	0.91	0.90	0.80	0.91	0.78	0.83	-
RETIRED	0.03	0.06	0.17	0.28	0.10	0.07	0.06	0.11	0.05	0.19	0.11	-
DIVORCED	0.11	0.10	0.19	-	0.11	0.15	0.15	-	0.16	0.18	0.11	-
WIDOWED	0.08	-	0.05	-	0.05	-	0.01	-	0.00	0.00	0.03	-
MARRIED	0.75	0.72	0.69	1.00	0.80	0.80	0.73	1.00	0.74	0.75	0.79	-
SEPARATED	-	0.02	0.06	-	0.00	-	0.02	-	0.02	0.04	0.02	-

Table 1.12: This table presents, in panel (A), the distribution of observations by year, and in (B), the employment industry across the different categories of maximum number of mortgages reached in the sample. There seems to be little difference across the different categories in the distribution of estimation observations by year. Additionally, there is little systematic variation in in industry of employment across maximum mortgage groups. See the text for a more detailed discussion.

Panel A

	1999	2001	2003	2005	2007	2009
2 Mortgages	25.79%	34.43%	23.56%	30.50%	28.72%	29.12%
3-4 Mortgages	54.21%	51.64%	59.73%	51.88%	45.30%	45.47%
5+ Mortgages	20.00%	13.93%	16.71%	17.62%	25.99%	25.41%

Panel B

	MM^{2}	$MM^{3,4}$	MM^{5+}	Total
Agriculture, Forestry, Fishing,	2.2%	3.0%	0.8%	2.3%
Mining	1.2%	0.4%	0.7%	0.7%
Utilities	0.4%	1.8%	1.5%	1.3%
Construction	9.0%	9.4%	8.9%	9.2%
Manufacturing	15.3%	19.0%	19.3%	18.0%
Wholesale Trade	4.6%	3.9%	3.1%	3.9%
Retail Trade	7.8%	6.0%	3.8%	6.0%
Transportation and Warehousing	3.2%	4.7%	4.0%	4.1%
Information	3.1%	3.4%	4.0%	3.5%
Finance and Insurance	5.3%	5.1%	6.8%	5.5%
Real Estate and Rental and Leasing	2.7%	1.6%	3.0%	2.2%
Professional, Scientific, and Technical Services	8.1%	6.8%	8.8%	7.6%
Management, Administrative and Support	1.6%	1.5%	1.7%	1.6%
Educational Services	7.0%	6.5%	7.6%	6.9%
Health Care and Social Assistance	7.4%	8.0%	7.8%	7.8%
Arts, Entertainment, and Recreation	1.5%	1.5%	1.8%	1.6%
Accommodations and Food Services	5.1%	4.2%	4.5%	4.5%
Other Services	3.5%	3.1%	2.0%	2.9%
Public Administration and Active	10.9%	10.3%	10.1%	10.4%

to MM^{5+} in their percentages represented in real estate and rental and leasing, and professional, scientific and technical services. In general, there is little to suggest a systematic difference between different groups.

Finally, if households who take out more mortgages are simply more inclined to use adjustable rate mortgages, this compositional effect could produce the observed pattern of increasing propensity to choose an adjustable rate mortgage with mortgage market participation when the different groups are aggregated in the same specification. To test if this is the case, an indicator variable for the maximum number of mortgages the household reaches in the sample period is created. The variables

MM_i^2, $MM_i^{3,4}$ and MM_i^{5+} take values of one if the maximum number of mortgages for the household is 2, 3 or 4, or 5 or more, respectively. These are then interacted with the measures of mortgage market participation. Table 1.13 presents relevant coefficient estimates. We see that the coefficient on the PM^2 interaction term for $MM_i^2 = 1$ is positive, as we would expect, however not significant. The coefficients on PM^2 and $PM^{3,4}$ are positive and increasing for $MM_i^{3,4} = 1$, with values of 16.2% and 17.9%. With a p-value of 9.3%, an F-test of the null hypothesis that coefficients on $MM_i^2 \times PM^2$ and $MM_i^{3,4} \times PM^2$ are equal cannot be rejected at the 5% level. The coefficients for $MM_i^{5+} = 1$ are also positive and increasing, with values of 25.4% and 31.9%. An F-test of the hypothesis that coefficients on $MM_i^{3,4} \times PM^{3,4}$ and $MM_i^{5+} \times PM^{3,4}$ are equal is also not rejected, and has a p-value of 45.2%. While there could be differences across groups, we see propensity to choose an ARM increasing in mortgage market participation for all categories. Statistical significance in the PM^2 variable might be due to the effects of the $MM^{3,4}$ group, but comparing the $MM^{3,4}$ and MM^{5+} groups, estimates on $PM^{3,4}$ are positive and significant for both $MM^{3,4}$ and MM^{5+} groups, which is consistent with the overall results.

Learning & Financial Sophistication

When calibrating their model to 1986-2001 interest rate data, Campbell and Cocco (2003) find that nominal ARMs dominate nominal FRMs in all of their simulations. It should be said that the authors do not stress this point, but it is suggestive that ARMs may be better, in a household welfare sense, than many people think. Additionally, if we look at the ex post costs of adjustable rate mortgages during the same time period, we see that ARMs would have saved homeowners a significant amount of money. Panel (A) of Table 1.14 shows the average relative interest costs at multiple horizons from 1986 to the most recent year available. Mortgage interest rate data comes from the Federal Home Loan Mortgage Corporations (Freddie Macs)

Table 1.13: This table presents coefficient estimates for mortgage market participation measures by category of maximum number of mortgages obtained by the household in the sample period. MM^j indicates that the household used a maximum of j mortgages during the sample period. All coefficients are from the same regression. Tests of equality across categories are included. P-values are in parentheses below point estimates. * indicates significance at the 10% level, ** at the 5% level and *** indicates significance at the 1% level.

Interaction			
Dependent Variable	PM^2	$PM^{3,4}$	PM^{5+}
MM^2	0.0441	-	-
	(0.3572)	-	-
$MM^{3,4}$	0.1620**	0.1788**	-
	(0.0128)	(0.0122)	-
MM^{5+}	-	0.2538***	0.3189***
	-	(0.0037)	(0.0007)
Test of $MM^2*PM^2 = MM^{3,4}*PM^2$			
F(1, 2997) = 2.82			
P-value = 0.0930			
Test of $MM^{3,4}*PM^{3,4} = MM^{5+}*PM^{34}$			
F(1, 2997) = 0.57			
P-value = 0.4522			

Primary Mortgage Market Survey (PMMS). Rates are taken from a survey of the largest mortgage lenders and are quoted offers, not closed deals. Adjustable rates use the initial rate published in the PMMS for the first adjustment period, and then the one year treasury yield together with the PMMS published margin. The values in the table are the annual average differences in the cost of an FRM relative to an ARM initiated in the same month for the given horizon. With this definition, positive values indicate FRMs were ex-post more expensive. At a 5 year horizon, there are only 3 years between 1986 and 2011 in which actual 5 year interest costs were higher for an adjustable rate mortgage versus a fixed rate mortgage, and in these cases the difference was on the order of 1-2%. In contrast, the advantages can be quite large. An individual who took out a fixed rate loan in 2000 would have

paid 30% more in the first five years of the loan than if an ARM had been chosen. This is during a time when more than 50% of households had a housing tenure of 6 years or less, according to the National Association of Realtors. We should also take note of the difference in total interest costs, which are even larger than for overall payments, indicating that not only would homeowners have paid less, they would have paid down principal faster.

Table 1.14 presents results for ex-post realized payments, however it is the expected present value of payments that is relevant to homeowners. Tucker (1991) simulated interest rate paths out to 30 years from the time of mortgage origination, and compared the present value of total FRM costs to total ARM costs at different holding periods. The 1-year constant maturity T-bill rate was modeled as $r_t^{TB} = r_{t-1}^{TB} + \sigma_{TB} \times \epsilon_t$, where σ_{TB} is the one year standard deviation of $\Delta r_t^{TB} = r_t^{TB} - r_{t-1}^{TB}$ and ϵ_t is a normal random variable with a mean of zero and variance of one. The parameter σ_{TB} was estimated using date from 1974 to 1989. He calculated the present value of FRM and ARM payments for different holding periods using this simulated interest rate process for the 50 months from January of 1985 through February of 1989. The present value of paying off the remaining principal at the end of the holding period is included in the calculation. Tucker found that for a discount rate of 4% and holding periods of less than 19 years, the expected present value of FRM payments exceeded the expected present value of ARM payments. For discount rates larger than 8%, the expected present value of fixed rate mortgage payments was larger for all holding periods.

One concern with Tucker's study is the model of interest rate used. In reality, interest rate processes are more stable and exhibit excess kurtosis than a random walk with a normal disturbance. Supplementing Tucker (1991), two different interest rate simulations were performed. The first model is a random walk with a disturbance which has a T-distribution. The model used is $r_t^{TB} = r_{t-1}^{TB} + \sigma_{TB} \times \eta_t$, where σ_{TB}

Table 1.14: Numbers represent the percentage difference in mortgage costs for a fixed rate mortgage relative to the costs of an adjustable rate mortgage initiated in the same month. With this definition, a value of 10% indicates ex post costs of an FRM were 10% more than for an ARM. Initial interest rates come from Freddie Mac's Primary Mortgage Market Survey, which represents the average rates offered to mortgage applicants. ARM rates in the PMMS are indexed to short term treasury rates, so yields from the Federal Reserve Board are used to calculate expected interest costs for ARMs. Panel (A) summarizes actual costs since 1986, while Panel (B) summarizes expected costs over the same period.

Panel A - Actual Differences in Mortgage Payments

Horizon		3	5	7	10
Difference Paid					
	Mean	10.7%	9.6%	10.9%	13.8%
	Median	8.5%	6.7%	10.0%	14.5%
Interest Difference					
	Mean	17.7%	15.1%	16.8%	21.5%
	Median	11.7%	9.7%	16.4%	21.5%

Panel B - Expected Differences in Mortgage Payments

Horizon		3	5	7	10
Difference Paid					
	Mean	2.2%	-3.3%	-6.3%	-8.8%
	Median	1.0%	-3.6%	-6.9%	-9.5%
Interest Difference					
	Mean	3.8%	-4.4%	-8.5%	-11.8%
	Median	1.4%	-4.7%	-9.5%	-12.9%

is now the standard deviation of monthly changes, $\Delta r_t^{TB} = r_t^{TB} - r_{t-1}^{TB}$, and η_t is a random variable following a T distribution with kurtosis to match that of the Δr_t^{TB} process and scaled to have a mean of zero and variance of one. The second simulation, following Brenner et al. (1996), models the change in interest rate as $\Delta r_t^{TB} = \alpha + \beta \times r_{t-1}^{TB} + \epsilon_t$ and models the volatility of the interest rate as a GARCH(1,1) process, where $E_{t-1}(\epsilon_t^2) = \sigma_t^2 = a_0 + a1 \times \epsilon_{t-1}^2 + b \times \sigma_{t-1}^2$. Parameters were estimated using the 1-year constant maturity T-bill rate from 1960 through 2011. Simulations were performed for monthly fixed and adjustable mortgage rates taken from Freddie Mac's Primary Mortgage Market Survey from 1986 through 2011. Present values were calculated for initial principal of \$100,000 and discount rates of 4%, 6%, 8%, and 10%. The difference in the present value of payments for FRMs and ARMs

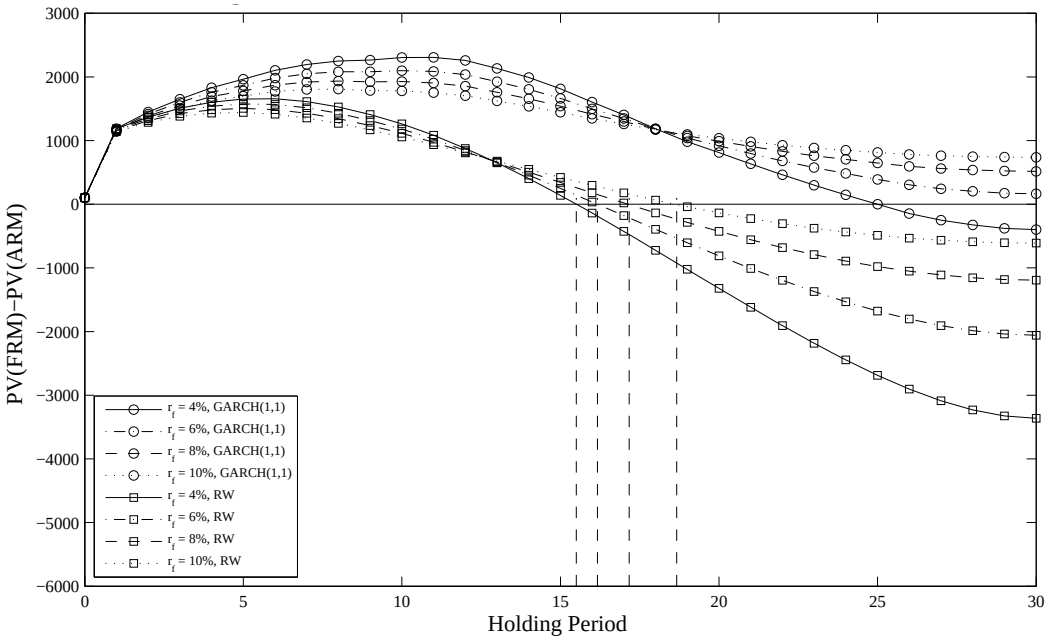

FIGURE 1.4: This graph shows the relative costs of ARMs and FRMs. It plots the present value (PV) of the difference E(cost of FRM) - E(cost of ARM) against the holding period in years. Circles indicate a GARCH(1,1) based simulation. A GARCH(1,1) model for monthly changes in the 1-year tbill rate was estimated using data from 1960 through 2011, following the methodology discussed in Brenner, Harjes, and Kroner (1996). For each month between January of 1986 and December of 2011, 100 simulations of the interest rate process were generated, and the present value of ARM costs for holding periods from 1 to 30 years was calculated. These values were then compared to the present value of an FRM originated in the same month. As a comparison, following Tucker (1991), simulations based on the random walk model $r_t^{TB} = r_{t1}^{TB} + \sigma_{TB} \times \eta_t$, where σ_{TB}, is the monthly standard deviation of the 1-year Treasury Bill rate. These simulations are indicated with square points.

is plotted against the holding period in years in Figure 1.4. Results are largely consistent with Tucker (1991). The present value of FRM payments are greater for all discount rates for holding periods of less than 15 years in the random walk model. For the GARCH(1,1) model, the present value of FRM payments are greater for all holding periods and all discount rates, except for a discount rate of 4%, where the expected present value of ARM payments exceeds those for FRMs for holding periods of greater than 25 years. Clearly, ARMs can have significant cost advantages over fixed rate contracts.

These results are tempered somewhat if we look at expected interest costs at the

time of acquiring a mortgage, as implied by simple forward rates, during the same time period. Panel (B) of Table 1.14 presents these figures. Calculations are made using the implied forward treasury rate from year t to t+1. We see that fixed rate mortgages have far lower expected costs than ARMs. It should be noted however that these rates do not account for any possible liquidity or term premium that may be a component in the forward rates, and should be regarded as an upper bound on the expected interest costs for an adjustable rate loan. Still, there is compelling evidence that ARMs may have significant advantages over FRMs for some households.

Another possible explanation for the increased propensity to choose an ARM with mortgage market participation, is that ARMs have the advantages discussed above, and that households do not know about or understand this early in their experience with mortgages. van Rooij, Lusardi, and Alessie (2011) demonstrate that higher financial literacy is associated with higher participation rates in the stock market, however there are two potential explanations for this. It may be that more financially literate households better understand the stock market, or it could be that participation in the stock market leads to higher financial literacy. The authors suggest "[...] people may be learning as they age and, perhaps, participate in financial markets" (van Rooij et al., 2011). If there are features of ARMs that are advantageous relative to FRMs, and households are unaware when getting their first mortgage, we might expect them to increase their usage of ARMs as they use more mortgages. The process of participating in the mortgage market may teach households about these contracts.

van Rooij, Lusardi, and Alessie (2011) show that frequent use of finance and economics in the work place is associated with higher participation rates in the stock market. We might expect, then, that people working in the financial or insurance sectors, or the real estate, renting and leasing sector, might be more apt to choose an ARM and increase the usage of ARMs faster with participation. Following the

previous methodology, we add the variable FW_{it}, taking a value of one if the head of the household works in the financial or real estate sectors, to the main specification. This variable is also interacted with our PM_{it}^{j} variables and included in the regression. As discussed above, we expect the coefficient on FW_{it} to be positive. Results are presented in column 1 of Table 1.15. There is an increase in propensity to choose an ARM for households with a head working in the financial sector. Though not statistically significant, the magnitude of the coefficient on FW_{it} is quite large. The coefficients on the interaction terms are also not significant, but they too are large and increasing, consistent with financial workers learning faster about advantages of ARMs. With only 260 observations for households with a head in the financial or real estate sector, statistical power is low, however magnitudes and directions are as we would expect if ARMs are advantageous and financial workers are better able to realize this. It should also be noted that the pattern of increasing usage of ARMs with mortgage market participation is still strong for households not in the financial sector. Here, as before, the coefficients are monotonically increasing, consistent with a slower learning process than households working in a financial industry.

We can narrow the scope of the idea of "financial sophistication" to sophistication in real estate markets, specifically. The PSID includes the question, "What was the total dollar cost of the additions or improvements, plus the value of any work you may have done yourself?" for the 1989, 1994 and 1999 through 2009 waves of the survey. We define the concept of "flipping" as expecting to move soon (the household responded "probably move" or "definitely move" to the PSID's question regarding the likelihood of moving) and spending in the top 30% of all homeowners on home improvement. Households who flip are buying, improving and selling homes quickly. Presumably they should become very familiar with mortgage markets during this process. We would expect "flippers" to learn more quickly about the advantages of ARMs, as they are interacting with mortgage brokers and banks on a regular

Table 1.15: This table presents within-household estimates of propensity to choose ARM. The first column investigates the relationship between mortgage market participation, ARM choice propensity and working in the financial or real estate sectors. The second column addresses households "flipping" properties. The final column investigates the implications of having obtained a graduate degree, and its interaction with mortgage market participation. Household clustered standard errors are in parentheses, with p-values beneath them. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	Finance Worker		Flipping		Graduate School
Dependent Variable	ARM_{it}		ARM_{it}		ARM_{it}
FW_{it}	0.2075	$FLIP_{it}$	-0.1969		
	(0.2324)		(0.1957)		
	0.3721		0.3145		
$FW_{it}*PM^2$	0.082	$FLIP_{it}*PM^2$	-0.1415	GS_i*PM^2	0.1489
	(0.1331)		(0.1783)		(0.1014)
	0.5377		0.4275		0.1421
$FW_{it}*PM^{3,4}$	0.1356	$FLIP_{it}*PM^{3,4}$	0.1191	$GS_i*PM^{3,4}$	0.2612**
	(0.216)		(0.21)		(0.1048)
	0.53		0.5706		0.0127
$FW_{it}*PM^{5+}$	0.2484	$FLIP_{it}*PM^{5+}$	0.5109*	GS_i*PM^{5+}	0.2080*
	(0.2723)		(0.2757)		(0.1208)
	0.3616		0.0639		0.0851
PM^2	0.0830*		0.0995**		0.0855*
	(0.0441)		(0.0431)		(0.0469)
	0.06		0.0209		0.0681
$PM^{3,4}$	0.1331**		0.1378**		0.1160*
	(0.0613)		(0.06)		(0.0647)
	0.0301		0.0217		0.0734
PM^{5+}	0.2091***		0.2122***		0.2110**
	(0.0791)		(0.0783)		(0.0823)
	0.0083		0.0067		0.0104
Controls	Yes		Yes		Yes
R2	44.27%		45.21%		44.87%
N	3,694		3,694		3,502

basis, and ARMs are also more advantageous for these people. Adding an indicator variable, $FLIP_{it}$ and interactions terms of $FLIP_{it}$ with PM_{it}^{j} variables, we get results presented in column 2 of Table 1.15. Though not significant, the coefficient on the interaction term for $j = 2$ we see that it essentially negates the coefficient on the raw PM_{it}^{2} term. For $j = 3$ or 4, the coefficient on the interaction term is positive, but not distinguishable from zero, however for $j = 5$ or more, the coefficient is positive and marginally significant. We see that after their second mortgage, the propensity to choose an ARM increases substantially for flippers. The negative coefficient on the indicator variable for flipping is interesting, but it is not statistically significant, and without further theory on the circumstances of households who choose to flip homes, we have no prior on what the sign of this coefficient should be. It should also be noted that the main pattern persists for non-flippers, consistent with learning being an important effect over the whole population.

Though van Rooij et al. (2011) explain that education is not necessarily a good proxy for financial sophistication, if households are learning, we might expect households with graduate degrees to be better able to identify the advantages of financial products with repeated exposure financial markets. We can include interaction terms of a variable equal to 1 if the head of the household has received a graduate degree, GS_i, with the measures of mortgage market participation. Coefficients on the interaction terms, given in Table 1.15 are positive, and for $j > 2$, significant, indicating households with graduate degrees increase their usage of ARMs with participation faster and to a greater degree than other households. This is consistent with households who likely have an advantage recognizing the benefits of ARMs learning about those advantages faster and to a greater degree than those with less ability.

Refinancing

If households are learning by participating in mortgage markets, we might ask how it is they are learning. It could be that the act of purchasing a home is essential to the learning, or it might be that purchase of the home unimportant, and it is the interaction with mortgage brokers that leads to this increased knowledge and understanding. We can turn to refinancing as a way to test this. An indicator variable for refinancing, $REFI_{it}$ is created and interacted with measures of mortgage market participation. Regression results are presented in Table 1.16, along with the main specification for comparison and convenience. We see that an indicator variable for the loan being for refinancing purposes is negative and marginally significant, while the interaction terms are approximately zero and not significant. There is a level effect whereby refinancing loans are less likely to be into adjustable rate products, but there is little difference in the context of increasing propensity to choose an ARM with mortgage market participation.

This is consistent with the way refinancing loans are treated vis-a-vis purchase money loans in some states [1]. While purchase money loans are universally non-recourse loans, where the most the bank can get back in the event of default is the value of the home, if the loan was for refinancing purposes, the bank can potentially garner wages or force the sale of other assets. With this difference in the treatment of the two loan types, refinance loans are relatively riskier and thus there is motivation not to choose an ARM. Additionally, one of the primary reasons to refinance quoted in most personal finance books is to "lock in a better rate." To the extent households adhere to this type of advice and it affects all households relatively equally, we would expect refinancing loans to be FRMs relatively more often. This would also show up as a level effect in this specification. The increasing propensity to choose

[1] for example, that state of California for loans originating before January 1, 2013

Table 1.16: This table presents regression coefficients including an indicator variable, $REFI_{it}$, and interacting it with measures of mortgage market participation. It shows that there is a level effect, whereby households who are refinancing have a lower propensity to choose an ARM, but do increase their usage with participation. Robust p-values are in parentheses. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	Main	Refinance
Dependent Variable	ARM_{it}	ARM_{it}
PM^2	0.0860**	0.0538
	(0.0475)	(0.2702)
$PM^{3,4}$	0.1505**	0.1394**
	(0.0266)	(0.0412)
PM^{5+}	0.2194***	0.2322**
	(0.0059)	(0.0123)
$Refi_{it}$		-0.1124*
		(0.0544)
$Refi_{it}*PM^2$		0.0939
		(0.1449)
$Refi_{it}*PM^{3,4}$		0.0339
		(0.6443)
$Refi_{it}*PM^{5+}$		0.0247
		(0.7707)
Controls and FE	Yes	Yes
R^2	43.89%	44.06%
N	3,694	3,694

an ARM even among households choosing to refinance suggests that households are not learning through the purchase process, per se, but through the financing process. Originating/refinancing a mortgage seems to have a similar effect, suggesting interaction with mortgage brokers and associated research is what drives the "learning."

1.3.2 SCF

Variables

We now turn to the SCF for external validation of results from the PSID. The SCF is usually structured as a series of representative cross-sectional surveys. However, the Federal Reserve Board chose to re-interview the 2007 sample to gauge how the extraordinary economic events of the 2007-2009 period affected household finances. Because there are only two panels in the survey, only a *relative* measure of previous mortgages could be imputed. In both the 2007 and 2009 surveys, the questionnaire asks "Is there a mortgage or land contract on this property, or another type of loan that uses this property as collateral?" The survey goes on to ask "Did you take out this mortgage to: refinance or rollover an earlier loan, borrow additional money on your home equity, or to do both? " The answers to these two questions can be used to impute a measure of previous mortgages. If the household had a loan in 2007, but it was not to refinance a previous loan, the number of mortgage is set to one. If the purpose of that loan was to refinance an earlier contract, then we know the household has had at least two mortgages in its history. If a new mortgage is taken out between 2007 and 2009 we add one to the number of previous loans. In the end we are only interested in within-household variation, so this relative measure of the number of mortgages is sufficient and we do not need to worry about how many loans a household actually had before the sample period.

The model in which we are interested is:

$$ARM_{it} = \Gamma * PREVIOUS\ MORTGAGE_{it} + \beta * X_{it} + \Theta * HFE_i + \epsilon_{it} \qquad (1.2)$$

Table 1.17: This table presents the main covariates used in the regression analysis of the Survey of Consumer Finances

Variable	Description
DEFINITELY MOVE	Self reported probability of moving in the next 2 years of 100%
LIKELY MOVE	Self reported probability of moving in the next 2 years more than or equal to 80%, but less than 100%
PROBABLY MOVE	Self reported probability of moving in the next 2 years between 20% and 80%
MAYBE MOVE	Self reported probability of moving in the next 2 years less than or equal to 20%, but not definitely staying
NET WORTH	Assets less liabilities of the household
NW/PRINCIPAL	Net worth normalized by original principal on the mortgage
TOTAL INCOME	Total household income from all sources for the year in which the mortgage was originated
MPMT/INCOME	Total annual mortgage payments normalized by total income
INCOME VOLATILITY	Ratio of a household's total income to the household's self reported "normal" income.
LOAN-TO-VALUE	Original principal as a percentage of the purchase price of the home
LOAN-TO-VALUE^2	Loan-to-value squared
REFINANCE	Indicator equal to 1 if the loan was to refinance an existing mortgage
EMPLOYED	Indicator equal to 1 if the head of the household is employed
AGE	Age of the head of the household
AGE^2/100	Age of the head squared
CHILDREN	Indicator equal to 1 if children are part of the household
MALE	Indicator equal to 1 if the head of the household is male
MARRIED	Indicator equal to 1 if the head of the household is divorced
DIVORCED	Indicator equal to 1 if the head of the household is married
WIDOWED	Indicator equal to 1 if the head of the household is widowed
SEPARATED	Indicator equal to 1 if the head of the household is separated
EMPLOYMENT INDUSTRY	Set of indicator variables for the industry in which the household is employed

Where ARM_{it} is, as before, an indicator for whether household i chose an adjustable rate mortgage at time t. The vector Γ is the coefficient on $PREVIOUS\ MORTGAGE_{it}$, which is also defined as before, however now we have $j \in \{2, 3\}$. The variable X_{it} is a vector of control variables including those listed in Table 1.17 most of which were discussed above. Because we are interested in *within* household variation, the within-estimator is used, which is equivalent to including household binary variables, HFE_i. It is important to note that the estimation sample contains only mortgage choice decisions observed in the 2007 survey for loans that were acquired in 2006 or 2007 and mortgage choice decisions in the 2009 survey for loans that were acquired in 2008 or 2009.

As discussed earlier, the shorter the expected tenure of a household in a given home, the larger the relative benefits of an adjustable rate mortgage. The measures of moving probability are slightly finer in the Survey of Consumer Finances. The SCF's panel survey included the question, "Using any number from zero to 100, where zero equals no chance and 100 equals absolutely certain, what do you think the chances are that you will be living at your current address two years from now?" Indicator variables for the households expected probability of moving are included to account for this effect in a non-parametric way. These variables include $DEFINITELY\ MOVE_{it}$, which takes a value of one if the household reports zero chance of staying at their current address. For a reported probability of staying greater than zero, but less than or equal to 20%, $LIKLEY\ MOVE_{it}$ is set to one. The variable $PROBABLY\ MOVE_{it}$ takes a value of one for reported probabilities between 20% and 80%, not inclusive, and $MAYBE\ MOVE_{it}$ is one when the reported probability of staying is greater than or equal to 80%, but less than 100%. The baseline case is if the household reports it is staying at its current address with 100% probability.

The coefficient vector of interest is $\Gamma = [\gamma_2\ \gamma_3]$. If households are increasing their usage of adjustable rate mortgages as they participate in the mortgage market, γ_2 and γ_3 should be positive, and monotonically increasing. That is, we should have $\gamma_2,\ \gamma_3 > 0$ and $\gamma_3 > \gamma_2$.

The SCF does not have information in the public release data files on geographic location of households, so unlike in the PSID, regional fixed effects are not included. However, broad employment industry dummy variables and a measure of the volatility of income are included. One of the most important considerations in the mortgage choice decision is household income volatility, which is correlated to industry of employment. The SCF collapses employment industry into seven broad categories, and an indicator for each of these industries is added to the regression. Additionally,

the SCF asks the question "Is this [total] income unusually high or low compared to what you would expect in a "normal" year?" The survey goes on to ask, "About what would your total income have been if it had been a normal year?" and the "normal " income is then recorded. As an additional measure of income volatility, the variable $INCOME\ VOLATILITY_{it}$, which is equal to the ratio of total reported income to the reported value of "normal" income, is included.

Mortgage Choice in the SCF

The longitudinal nature of the data makes it possible to investigate within-household propensities. Table 1.18 presents results for the main specification. The coefficients on the variables for the number of previous mortgages are as expected: positive and monotonically increasing. However, we fail to get statistical significance below the 10% level. Even with such a short panel, the Survey of Consumer Finances 2009 Panel only has two observations for each household, we get marginal significance for the coefficient on PM_{it}^2. Looking at the other controls, we see that again, measures of mobility are important determinants of the choice of mortgage contract. Though the coefficients do not increase monotonically, they are mostly significant and all are positive. The measure $INCOME\ VOLATILITY$ loads significantly, indicating large positive differences between current income and "normal" income increase the propensity to choose an ARM. Contrasting with the estimates for the PSID, $EMPLOYED$ loads positively and with marginal significance, however similar to the PSID the coefficient on AGE is negative and significant at the 5% level. The coefficient on $CHILDREN$ is negative and marginally significant. Interestingly, $MARRIED$ and $DIVORCED$ load negatively, while in the PSID the coefficient on $MARRIED$ was insignificant and on $DIVORCED$ was positive and significant.

We can repeat some of the analysis from above. Table 1.19 presents additional specifications, with the first column showing the main specification for comparison,

Table 1.18: This table presents estimates for the regression of ARM_{it} on relative measures of mortgage market participation and controls in the SCF. Robust p-values are in parentheses next to coefficient estimates. * indicates significane at the 10% level, ** indicates signficance at the 5% level, and *** indicates significance at the 1% level.

ARM_{it}	(1)	(2)	(3)	(4)	(5)	(6)
PM^2_{it}	0.3069**	0.2813*	0.2685*	0.2542*	0.2415*	0.2132
	(0.0365)	(0.0623)	(0.0781)	(0.0683)	(0.0868)	(0.1435)
PM^3_{it}	0.5400**	0.4999**	0.4788**	0.4906**	0.4690**	0.4125*
	(0.0215)	(0.037)	(0.0471)	(0.026)	(0.0344)	(0.071)
MAYBE MOVE		0.1777**	0.1859**	0.2196**	0.2253***	0.2225**
		(0.0476)	(0.0365)	(0.0124)	(0.01)	(0.0105)
PROBABLY MOVE		0.0244	0.0321	-0.0078	-0.0053	0.0649
		(0.8607)	(0.8181)	(0.9544)	(0.9689)	(0.5379)
LIKELY MOVE		0.3011**	0.3632**	0.5194***	0.5183***	0.4950***
		(0.0257)	(0.0108)	(0.0041)	(0.0031)	(0.0031)
DEFINITELY MOVE		0.1322	0.1386	0.1555	0.1587	0.2440**
		(0.2726)	(0.2479)	(0.1845)	(0.1747)	(0.0415)
NET WORTH			0.0000*		0	0
			(0.0658)		(0.2954)	(0.2194)
NW/PRINCIPAL			-0.0149		-0.0121	-0.0113
			(0.1647)		(0.2173)	(0.2238)
TOTAL INCOME				0.0000*	0	0
				(0.0863)	(0.1448)	(0.2563)
MPMT/INCOME				0.3771	0.3715	-0.2091
				(0.2739)	(0.2865)	(0.5667)
INCOME SURPRISE				0.3815***	0.3819***	0.2929**
				(0.0026)	(0.0024)	(0.0107)
LTV					0.1381	0.1381
					(0.5122)	(0.5122)
LTV^2						-0.0299
						(0.1567)
Demographics	Yes	Yes	Yes	Yes	Yes	Yes
Employment Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	39%	41%	41%	46%	46%	50%
N	1,028	1,028	1,028	1,027	1,027	1,025

the second through fourth columns relating to income, and the final two relating to education and information acquisition. Column 2 presents results investigating the interaction of household beliefs about inflation and their income, and the choice of an ARM in the context of mortgage market participation. In both 2007 and 2009, the SCF asked respondents "Over the next year, do you expect your total (family) income to go up more than prices, less than prices, or about the same as prices?" An indicator variable taking a value of 1 if the respondent felt their purchasing power would increase over the next year was included and interacted with the relative number of mortgages the household has used. We would expect those who expect real income to increase in the future to be more inclined to risk the variable payments of an ARM, and this is what we see, though coefficients are not significant. In the third column, results are presented for a regression including a variable equal to 1 if the household indicates they "usually have a good idea" of what their family's income will be the following year. Coefficients on the interaction terms are positive and increasing, however, they are insignificant. The fourth column analysis if those who had a large positive shock to income (in the top 25% of households, measure relative to normal income) are driving the results. Interestingly, the interaction term for 3 mortgages is negative and significant. It is possible these households are not expecting future income to be as high, and are unwilling to risk the variable payments of an ARM.

The fifth column of Table 1.19 interacts an indicator equal to 1 if the household head has a graduate degree with the measures of mortgage market participation. Coefficients are again insignificant, however, the pattern on raw participation variables persists, and is more pronounced for those with a graduate degree. Additionally, the direction of the coefficients is consistent with those from the PSID. In the sixth column, a variable taking a value of 1 if the household head uses the internet as his primary source of information about borrowing is included and interacted with

Table 1.19: This table gives coefficient estimates from fixed effect regression models of ARM_{it} on the measures of mortgage market participation. All estimates are computed accounting for the multiple imputation methods used by the SCF and using survey provided weights. Household clustered standard errors are in parentheses with p-values beneath them. * indicates significance at the 10% level, ** indicates significance at the 5% level, and *** indicates significance at the 1% level.

Indicator		Increasing PP	Knows Income	Pos. Inc. Shock	Grad School	E-Finance
Dependent Variable	ARM_{it}	ARM_{it}	ARM_{it}	ARM_{it}	ARM_{it}	ARM_{it}
PM^2_{it}	0.2132	0.1735	0.1843	0.2071	0.2277	0.248
	(0.1456)	(0.1836)	(0.2091)	(0.1615)	(0.1445)	(0.1712)
	0.1435	0.3448	0.3785	0.2	0.1154	0.1477
PM^3_{it}	0.4125*	0.3484	0.2448	0.4284*	0.3569	0.4228
	(0.2282)	(0.2661)	(0.3033)	(0.2367)	(0.2345)	(0.2603)
	0.071	0.1908	0.4198	0.0707	0.1283	0.1047
Indicator		0.0131	0.0335	0.4340*		0.1332
		(0.188)	(0.1827)	(0.2246)		(0.1813)
		0.9446	0.8547	0.0537		0.4626
Indicator*PM^2_{it}		0.0599	0.0221	-0.3195	-0.0934	-0.0803
		(0.2328)	(0.1991)	(0.2602)	(0.1562)	(0.1999)
		0.797	0.9117	0.2197	0.5499	0.688
Indicator*PM^3_{it}		0.321	0.1624	-0.6051**	0.2374	-0.0359
		(0.3022)	(0.1989)	(0.2539)	(0.2429)	(0.2432)
		0.2884	0.4144	0.0174	0.3287	0.8826
Controls and FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	49.96%	51.67%	50.54%	52.88%	51.76%	51.04%
N	1,025	1,025	1,025	1,025	1,025	1,025

participation variables. Coefficients on the interaction terms are close to zero, and the pattern for mortgage contract choice, though again not significant, is still there for those who do not use the internet as their primary source for information on borrowing.

Also notice that, though significance is lost in all but the specification for a large income shock, the pattern of increasing propensity to choose an ARM increasing with mortgage market participation is a feature of the SCF as well as the PSID. With such a short panel, statistical power is low for within-household effects, however, results align with those from the PSID, particularly in the case of mortgage market participation. Though results are not as significant, it is clear that the phenomenon of increasing propensity to choose an ARM is not isolated to the PSID.

1.4 Conclusion

A household's choice between an adjustable rate mortgage and a fixed rate mortgage has never been empirically investigated in a time-series context. Previous studies have looked at mortgage contract choice in a cross-sectional framework only. The positive relationship between mortgage market participation and propensity to choose an ARM discussed in this paper is a novel stylized fact not previously documented. This pattern is robust to an array of cross-sectional factors previously shown to influence the choice of an adjustable rate mortgage. Evidence is present supporting household learning as a possible explanation for this observed pattern. Additionally, this phenomenon is not confined to a single data set, but is observed in both the PSID and the SCF.

Financial market participation could have significant effects on other markets as well. As van Rooij et al. (2011) show, stock market participation is highly correlated with financial literacy, however, the direction of causality is not known. It is unclear if households who are financially literate participate, or households who participate become financially literate. While this paper gives some evidence that participation may affect literacy, this needs to be investigated in other contexts. One potential avenue is investigating diversification in the context of stock market participation. It would be interesting to see if households are better diversified after longer or more concentrated interaction with stock markets.

Finally, if participation influences decisions, what is changing for households? Is it an understanding of the risks involved, the institutional details of the market, or just a general understanding of financial concepts? If they are acquiring information by participating in financial markets, it suggests better education is needed prior to entering the marketplace. However, without knowing what it is households might be learning, no recommendation can be made regarding what information should

be presented to consumers. The evidence presented suggests theory should account for experience in financial markets when household decisions are being considered. Guidance is needed for empirical researchers regarding how a household's acquisition of information influences financial markets and how households interact with those markets.

2

Participation Effects and Optimal Refinancing

2.1 Introduction

In the U.S., households have almost $9.4 trillion in mortgage liabilities, which is more than half of their total real estate assets of about $18.4 trillion [1]. With mortgages being such large liabilities for households, refinancing is one of the most important financial decisions a household will make in its lifetime.

Borrowers refinance existing mortgages for several reasons. First and foremost, a household will refinance in order to lower the interest rate it pays on the loan (Canner, Luckett, and Durkin, 1990). This may have several advantages for the household, including lowering the monthly payment, or allowing the household to pay off the mortgage more quickly. Additionally, borrowers may refinance to remove equity from their home, for any of a number of reasons, including to pay off other debts, invest in a personal business, or send children to college (Canner et al., 1990). There are many studies where optimal refinancing rates, that interest rate below which it is optimal to refinance when households are not motivated by equity extraction, are

[1] Financial Accounts of the United States (Z.1), Board of Governors of the Federal Reserve System, June, 2013

calculated: Dunn and McConnell (1981), Chen and Ling (1989), Yang and Maris (1996), Longstaff (2005), Kalotay, Yang, and Fabozzi (2004, 2007, 2008) and most recently, Agarwal et al. (2012).

This study uses the method of Agarwal et al. (2012) to calculate optimal refinancing rates for households in the Panel Study of Income Dynamics (PSID), and shows that the propensity to refinance optimally increases with mortgage market participation, as measured by the number of previous mortgages used by the household. Increasing optimal refinancing with participation in mortgage markets is a novel fact, not previously documented, and is both robust to, and stronger when, controlling for equity extraction as the motivation for refinancing. This is consistent with an information acquisition model whereby households gain knowledge and understanding of financial transactions by participating in financial markets.

Previous authors have investigated the determinants of a household's decision to refinance [2]. Green and Shoven (1986) shows that the probability of refinancing is negatively related to a the size of the "lock-in", which is the difference between the book and market value of the mortgage, normalized by the approximate value of the home. The strength of this lock-in effect was shown to be decreasing with tenure in the home by Quigley (1987). That study also relates prepayment of a mortgage to family size and education of the household head, showing prepayment is positively related to both variables. Consistent with the option to wait on refinancing being more valuable with higher interest rate volatility, [3], Giliberto and Thibodeau (1989) shows that the term of a mortgage loan is increasing in interest rate volatility. Giliberto and Thibodeau (1989) also shows that loan tenure is negatively related to household income. This suggest that an ability to afford increased payments can increase the likelihood of refinancing to cash out equity. Supporting the argument that

[2] see Dickinson and Heuson (1994) for an excellent review of the this literature, to that point.

[3] see Kau and Keenan (1995) for an overview of option-theoretic pricing of mortgages

higher income increases the propensity to refinance, Dickinson and Heuson (1992) finds that borrowers will require a smaller savings in monthly payments when their income is substantially higher than required to support the incumbent mortgage. Additionally, the authors show that a smaller payment savings will be required to refinance when the value of the home has risen substantially since purchase.

While the majority of mortgage loans in the United States are fixed rate mortgages (FRMs), a substantial fraction of mortgages are of the adjustable rate variety (ARM). Consequently, the literature has focused on FRMs, however a few authors have looked at termination behavior when the incumbent loan is an adjustable rate mortgage. Zorn and Lea (1989), using data on ARMs in Canada, showed that the indirect utility of prepayment to the ARM borrower is negatively related to the opportunity and real costs of prepayment, including the rate of return on other assets, prepayment penalty and cost of leasing or renting. Simultaneously, prepayment utility was shown to be positively related appreciation in housing prices and the mortgage contract rate. This suggests the motivations, both financial and non-financial, are similar for ARM and FRM borrowers. Contrasting to the incentives to refinance for an FRM borrower, Cunningham and Capone (1990) shows that ARM prepayments are less positively related to the slope of the yield curve and are negatively related to the size of interest rate adjustment caps for both the individual adjustments and life-of-loan caps.

These papers all investigate determinants of prepayment cross-sectionally. This thesis will break from this pattern, and examine how the behavior of household changes across time. Additionally, whereas previous studies look at prepayment overall, this study investigates optimal refinancing, casting it in the context of mortgage market participation.

The rest of this section is organized as follows. Section 2 will discuss the data used, section 3 will present results, and section 4 will conclude.

2.2 Data

The data used in this study come from the Panel Study of Income Dynamics (PSID) administered by the Survey Research Center at the University of Michigan. The PSID is a longitudinal survey conducted annually from 1968 to 1997, and biennially since 1997. The most recent year for which data are available is 2009. See section 2.1 and Table 1.1 of Chapter 1 for a detailed discussion of the PSID data.

This study augments the data provided in the PSID with estimates of the optimal refinancing rate when equity extraction is not a motivation, following the method of Agarwal et al. (2012) [4]. These figures are used to generate a sample of optimal refinancing events in the PSID. Optimal refinancing rates are a function of several variables [5]. The variable,$RemPrinc_{it}$, is the remaining principal on the existing mortgage. The larger the remaining principal is, the higher the optimal refinancing rate will be, because interest costs are proportionally larger for a loan with a higher principal. The number of years left on the existing mortgage is represented by $YrsRemaining_{it}$. The higher this value is, the higher the optimal interest rate will be, resulting from having a larger proportion of interest costs remaining to be paid on the incumbent loan. $TaxRate_{it}$ is the marginal tax rate and has a negative relationship with the optimal refinancing rate. This is a consequence of the tax advantaged status of interest payments. Remaining time in the home is included as $ExpTenure_{it}$, which has a positive relationship with the optimal refinancing rate because the household will have a longer time to reap the benefit of a lower interest rate. $Points_{it}$ and $CloseCosts_{it}$ are the points and fixed costs on the new mortgage, respectively. As we would expect, these have a negative relationship with the optimal refinancing rate, as a higher payment savings is required to offset these

[4] see http://zwicke.nber.org/refinance/ where the authors provide a calculator for the optimal refinance rate

[5] see Table 2.1 for definitions of variable names

costs. Finally, we have $DiscountRate$, $AvgInflation$, and $MortgRateSD$, which represent the household's discount rate, expected average inflation over the life of the new loan, and mortgage interest rate volatility. Discount rates have a negative relationship with the optimal refinancing rate, as the present value of future savings is relatively lower. As well, higher average inflation reduces the real value of future savings, and induces a lower required interest rate to refinance optimally. Due to the well known relationship between volatility of the underlying and the value of an option, higher mortgage rate volatility induces a lower required refinancing rate, because the option to wait for an even lower rate is more valuable.

Table 2.1: This table presents and explains the variables used to calculate the optimal refinancing interest rates following the method in Agarwal et al. (2012)

$RemPrinc_{it}$	Remaining principal in incumbent loan at of household i at time t
$YrsRemaining_{it}$	Remaining term on incumbent loan
$InterestRate_{it}$	Interest rate for incumbent loan
$TaxRate_{it}$	Household marginal income tax rate
$ExpTenure_{it}$	Years expected to remain in the home
$Points_{it}$	Points on the new mortgage
$CloseCosts_{it}$	Other closing costs on the new mortgage
$DiscountRate$	Annual discount rate
$AvgInflation$	Average expected inflation over life of new loan
$MRateSD$	Annualized standard deviation of mortgage interest rates

Values for $RemPrinc_{it}$, $InterestRate_{it}$, $YrsRemaining_{it}$, and $TaxRate_{it}$ were taken directly from the PSID to calculate optimal refinancing rates. The taxable income reported by household in the PSID was used to ascertain a household's marginal tax rate, $TaxRate_{it}$. Using the National Association of Realtors Profile of Homebuyers and Sellers (PHS) [6] from 2006-2009 and the self reported probabilities of moving discussed in Chapter 1, households were assigned values for expected tenure as follows: if a household reported they would definitely move within two years, they were

[6] see http://www.realtor.org/topics/profile-of-home-buyers-and-sellers for the current survey results

assigned a value of two for $ExpTenure_{it}$. If they reported the would probably move, or might move, they were assigned an expected tenure of 4 or 6 years, respectively. If a household answered that they could not assign a likelihood to their moving, they were assigned an expected tenure based on their age and the reported medians by age groups in the PHS. Since this value was not reported in the PHS years before 2006, the 2006 values were used for all previous years [7]. $Points_{it}$ were assigned according to the annual national averages released by Freddie Mac as part of their Primary Mortgage Market Survey (PMMS). [8] Finally, following calibrations in Agarwal et al. (2012), household discount rate was assumed to be 5%, expected inflation was assumed to be 3%, closing costs were assumed to be $2,000 and volatility of mortgage rates was assumed to be 1.04% for all households.

2.3 Optimal Refinancing in the Panel Study of Income Dynamics

Using the data discussed above, a panel of optimal refinancing events was generated, where a household refinanced when the national 30-year fixed rate mortgage rate, as released in the PMMS, was below a household's optimal refinancing rate. An indicator variable, $OptRefi_{it}$ taking a value of one if a household optimally refinanced when they should have refinanced, is regressed on a number of covariates. The most relevant of these regressors to our study are $PM_{it}^{j}, j = 3, 4, 5+$, where j represents the number of previous mortgages the household has used. The remainder of the covariates are similar to those from Chapter 1, but are presented in Table 2.2 for convenience.

Our main empirical specification is

$$OptRefi_{it} = \Gamma * PM_{it} + \beta * X_{it} + \Psi * AFE_{it} + \epsilon_{it} \tag{2.1}$$

[7] It should be noted that other variables, such as tenure in previous home, remained relatively constant from 2003-2005, the first three years the PHS was available

[8] see http://www.freddiemac.com/pmms/ for more information and historical data

Table 2.2: This table presents the controls used in the main regressions, to be presented and discussed below

Variable	Description
DEFINITELY MOVE	Indicator for self reported probability of moving in the next 2 years of
LIKELY MOVE	Indicator for self reported probability of moving in the next 2 years being "probably move"
MAYBE MOVE	Indicator for self reported probability of moving in the next 2 years being "maybe move"
NET WORTH	Assets less liabilities of the household
NW/HOUSE VALUE	Net worth normalized by original principal on the mortgage
HVAL/INCOME	Value of the home normalized by total income
TOTAL INCOME	Total household income from all sources for the year in which the mortgage was originated
INCOME/MPMT	Total annual mortgage payments normalized by total income
LOAN-TO-VALUE	Original principal as a percentage of the purchase price of the home
LOAN-TO-VALUE^2	Loan-to-value squared
EMPLOYED	Indicator equal to 1 if the head of the household is employed
RETIRED	Indicator equal to 1 if the head is retired.
AGE	Age of the head of the household
AGE^2/100	Age of the head squared
CHILDREN	Indicator equal to 1 if children are part of the household
NUM CHILDREN	The number of dependent children in the household
MALE	Indicator equal to 1 if the head of the household is male
WIFE POWER	A measure of the realative bargaining power of the wife in the household
MARRIED	Indicator equal to 1 if the head of the household is divorced
DIVORCED	Indicator equal to 1 if the head of the household is married
WIDOWED	Indicator equal to 1 if the head of the household is widowed
SEPARATED	Indicator equal to 1 if the head of the household is separated

where $PM_{it} = [PM_{it}^3\ PM_{it}^4\ PM_{it}^{5+}]$, X_{it} is a vector of controls, discussed above and presented in Table 2.2 and AFE_{it} is a vector of fixed effects, including household, time and time interacted with industry of employment. Regressions are restricted to households who have use two or more mortgages, and have consequently had a chance to refinance at least once, and who *should* refinance, but may or may not. Our main interest is in how a household's propensity to refinance optimally increases with participation in mortgage markets, so the focus will be on the coefficient estimates on the vector PM_{it}

The main results are presented in Table 2.3. We see that in all models, the propensity to optimally refinance is increasing in mortgage market participation. We should note that inclusion of the income variables has the biggest effect on the estimated coefficients on the PM^j variables. This is consistent with the literature

discussed above, showing that households with higher income require smaller payment savings to refinance. It is likely that these households are following popular advice regarding refinancing, such as the break even rule, and doing it too soon. In the setup here, that could qualify as a sub-optimal refinancing, which explains the negative sign on the coefficient for income normalized by housing payment.

Table 2.3: This table shows the effects of participation on optimal refinancing. Coefficients should be interpreted as *within* household contributions to the propensity to refinance optimally. For the mortgage market participation variables, PM^j, coefficients are difference in the propensity to refinance optimally relative to the *first* potential refinancing event (i.e. the second mortgage). P-values for the coefficients are in parentheses, and use heteroskedastic robust and clustered standard errors.

	(1)	(2)	(3)	(4)	(5)	(6)
PM^3	0.0295**	0.0299**	0.0701***	0.0493***	0.0705***	0.0615**
	(0.0159)	(0.0229)	(0.0028)	(0.0016)	(0.0026)	(0.0224)
PM^4	0.0820***	0.0825***	0.1331***	0.1017***	0.1330***	0.1330***
	(0)	(0.0001)	(0.0003)	(0)	(0.0003)	(0.0023)
PM^{5+}	0.0935***	0.0957***	0.1711***	0.1251***	0.1715***	0.1614***
	(0.0001)	(0.0001)	(0.0005)	(0)	(0.0005)	(0.0036)
MAYBE MOVE		0.0078	-0.0009	0.006	-0.0007	0.0073
		(0.4372)	(0.9772)	(0.6794)	(0.9805)	(0.8189)
LIKELY MOVE		0.0059	0.0314	0.0248	0.0318	0.064
		(0.6297)	(0.4535)	(0.2255)	(0.4509)	(0.1544)
DEFINITELY MOVE		0.0066	0.0037	0.0123	0.0039	-0.0036
		(0.6113)	(0.9223)	(0.5155)	(0.9187)	(0.93)
HVAL/INCOME			-0.0004**		-0.0004*	-0.0005*
			(0.0348)		(0.0504)	(0.0552)
TOTAL INCOME			-0.0071***		-0.0068**	-0.0094**
			(0.0079)		(0.0284)	(0.0161)
INCOME/MPMT			0.0001		0.0001	-0.0005
			(0.1085)		(0.1098)	(0.4617)
NET WORTH				0*	0	0
				(0.0513)	(0.7694)	(0.9905)
NW/HOUSE VALUE				0.0014	0.0012	0.0032
				(0.3746)	(0.8657)	(0.7025)
LOAN-TO-VALUE						0.0073
						(0.9205)
$LOAN\text{-}TO\text{-}VALUE^2$						-0.0478
						(0.3532)
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes
R^2	39%	40%	48%	43%	48%	52%
N	8,092	7,869	4,685	6,464	4,685	4,263

2.3.1 Equity Extraction and Optimal Refinancing

One of the primary motivations for refinancing is to extract equity from the a household's home. One might want to do this for several reasons, including home improvement, unexpected or large expenses like college tuition for children or continuing education or a need for cash due to illness or unemployment. I repeat the main analysis, but exclusively control for cross sectional differences in these factors by creating indicator variables and interacting them with measures of mortgage market participation. Results are presented in Table 2.4, where indicator variables are shown at the top of each column and include a large amount of time spent ill and unable to work ($ILLTIME^{30}$), a large (more than a month) amount of time spent unemployed ($UEMPTIME^{30}$), children in, or soon to be in, college ($CHILD^{15}$), and large school expenses relative to income ($SEI^{0.2}$), which is defined to be school expenses in excess of 20% of total household income.

The most interesting results are for time spent without working, due to illness or unemployment. Interestingly, there is a large and significant level effect due to inability to work. For both columns one and two, the intercept for groups indicated by $ILLTIME^{30}$ and $UEMPTIME^{30}$ is large and negative, indicating these two groups tend to optimally refinance less, overall. This is exactly what would be expected if they were not refinancing to take advantage of low rates, but because other life circumstances demanded they remove equity from their home. It is important to note that this effect does not influence the main result, that households are more likely to optimally refinance with greater mortgage market participation. As well, even households motivated by equity extraction have a greater propensity to refinance optimally if with more mortgage market participation, as indicated by the small and insignificant coefficients on the interaction terms.

Having a child soon to be, or in, college or otherwise high school related expense,

Table 2.4: This table repeats the main analysis, but includes indicator variables for potential equity extraction motivation interacted with measures of mortgage market participation. These include a large amount of time spent ill and unable to work ($ILLTIME^{30}$) or a large amount of time spent unemployed ($UEMPTIME^{30}$), children in, or soon to be in, college ($CHILD^{15}$) and large school expenses relative to income ($SEI^{0.2}$). Please see the text for a detailed discussion of these variables. P-values are in parentheses below point estimates. * indicates significane at the 10% level, ** at the 5% level and *** indicates significance at the 1% level.

	$ILLTIME^{30}$	$UEMPTIME^{30}$	$CHILD^{15}$	$SEI^{0.2}$
PM^2	0.0538*	0.0600*	0.0641**	0.0611**
	(0.0782)	(0.0504)	(0.0179)	(0.0238)
$PM^{3,4}$	0.1090**	0.1157**	0.1412***	0.1183***
	(0.0188)	(0.0128)	(0.0015)	(0.0075)
PM^{5+}	0.1376**	0.1356**	0.1595***	0.1508***
	(0.0159)	(0.0173)	(0.0043)	(0.0067)
IND_{it}	-0.0837***	-0.1015***	0.0229	-0.1297
	(0.0015)	(0.0001)	(0.6025)	(0.2472)
$IND_{it}*PM^3$	0.0066	0.0237	-0.0361	0.1636
	(0.8241)	(0.4286)	(0.523)	(0.1579)
$IND_{it}*PM^4$	0.0508	0.0217	-0.1514**	0.3573**
	(0.2823)	(0.632)	(0.0433)	(0.0334)
$IND_{it}*PM^{5+}$	0.0512	-	0.0363	0.0613
	(0.5516)	-	(0.7324)	(0.7366)
Controls	Yes	Yes	Yes	Yes
	52.4%	52.4%	52.1%	52.4%
	4,263	4,263	4,263	4,228

might also be a motivation for equity extraction. In the third column of Table 2.4, an indicator variable if the youngest child in the household is over 15 years of age is included and interacted with measures of mortgage market participation. The idea here is that a household with a youngest child nearing college, is likely to have a college age child already, or at least be thinking about upcoming college tuition expenses. This could be motivation to refinance the home and extract equity. We see that, this might be the case, as indicated by the negative and significant coefficient on the interaction term with PM^4, however the main results hold for households who do not have a soon to be college age youngest dependent.

Along similar lines to the inclusion of an indicator for a college age child in the household, the PSID includes direct measures of school expense. If this is large relative to income (defined here as more than 20% of income), we might expect the household to extract equity to pay for these educational expenses. We see in column four of Table 2.4 that these households, if increase their propensity to optimally refinance at a higher rate than the general population, as shown by the positive coefficients, and the significant coefficient on the interaction term with PM^4. Overall the results presented in this section are consistent both with equity extraction driving sub-optimal refinancing, and an increased propensity to refinance optimally with mortgage market participation, even when equity extraction concerns are controlled for.

2.4 Conclusion

It is important to understand how and why households make financial decisions. In aggregate, household assets account for a substantial fraction of all assets in the United States economy. In addition, if households are making fundamental mistakes in their financial life, as some research suggests, it is important we understand if they can improve that behavior. This study demonstrates that one mechanism through which households improve their understanding and knowledge of financial markets is participation. The simple, but potentially costly, act of repeatedly using mortgage products leads to more optimal outcomes at an individual household level.

On a more general note, the fact that households are improving financial decision making by participation suggests there is room for improvement in our financial education system. Making mistakes when getting a mortgage can be very costly. As demonstrated, home values are typically well above 50% of total household assets for much of the wealth distribution, and most of this is financed through a mortgage. Better education of households is an opportunity to save them and the economy

money in the long run.

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Biography

Stuart James Webb was born in Akron, Ohio on November 30, 1985, and grew up in Hudson, Ohio, graduating from Hudson High School in 2004. He went on to complete his undergraduate studies at Washington University in St. Louis in 2008, majoring in Mathematics and Finance, with a minor in Economics. Stuart completed his graduate studies in Business Administration with a major in Finance at Duke University's Fuqua School of Business, with the degree of Doctorate of Philosophy in Business Administration being conferred in September, 2013.